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INFORMATION SERVICES FOR COMPARATIVE ANALYSIS OF BIORHYTHM RESEARCH

FINAL REPORT

AMES RESEARCH CENTER CONTRACT NO. NAS2-6216
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BIOLOGICAL SCIENCES COMMUNICATION PROJECT
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Department of Medical and Public Affairs
2001 S Street, N.W., Washington, D.C. 20009

for

AMES RESEARCH CENTER

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

This report lists references and full text documents from the scientific literature selected in support of continuing research and research planning for the NASA Ames Research Center behavioral physiology program. The Biological Sciences Communication Project has furnished this information in response to requests from the technical monitor throughout the contract period. References and abstracts included here are representative of the information provided; exhaustive bibliographic coverage of any subject area is not intended. Over one thousand additional references were supplied, but are not listed in this report.

Other information services provided included informal communication with organizations and researchers as directed by the technical monitor; documentation and style editing of manuscripts; and participation in research planning meetings at Ames Research Center.

CONTENTS

DESYNCHRONOSIS AND PERFORMANCE

The collection of material on desynchronosis of biological rhythms contains references on time zone displacement, spaceflight and ground-based isolation studies. The areas of shift-work, drug or disease induced rhythm variations are represented only to a limited degree. Material relating sleep, environmental and work/rest scheduling to physiological, psychological and performance decrements during air travel are the prime consideration.

1. ADAM, J.M. 1969.
Disturbances of nychthemeral rhythm due to air travel.
J. Royal Army Med. Corps 115(1):14-18.

2. ADAM, J.M., M.C. LOBBAN and B.E. TREDRE. 1965.
Diurnal rhythms of renal excretion and of body temperature in Indian subjects after a sudden change of environment.
J. Physiol. (London) 177:18P-19P.

3. ALIAKRINSKII, B.S. 1967.
(Principles and research methods of the space day problem.) Printsipy i puti issledovaniia problemy kosmicheskikh sutok. 1967.
In: N.N. Gurovskii, ed. Ocherki Psikhofiziologii Truda Kosmonovtov. Moscow, Izdatel'stvo Meditsina. p. 68-76.

The author discusses factors determining the work/rest regime for cosmonauts, including the characteristics and after-effects of the work at control panels, artificial light, characteristics of muscular activity, and number of crew members and their individual adaptability. He also reviews the results of experiments and observations on adaptability to changed circadian rhythms, offers a variety of day lengths and emphasizes the importance of experiments in which only one factor is changed at a time. As an object of further research programs he recommends such factors influencing adaptation as drugs, afferentation changes, psychological training, and the creation of methods for determining individual adaptability. (I.A.A.)

4. ALIAKRINSKII, B.S. 1970.
Problems of latent desynchronosis.
Life Sciences and Space Research VIII:171.

5. ALIAKRINSKII, B.S. 1970.
Psychological factors of prolonged space flights.
In: A.A. Blagonravov et al, ed. Transactions of the First Lectures Dedicated to the Development of the Scientific Heritage of K.E. Tsiolkovskiy. p. 98-105.
National Aeronautics and Space Administration, NASA-TT-F-544, Washington, D.C.

The basic trends in research within the scope of space psychology are established by the features of the conditions of life and activity of man in space. Among these conditions, the most important significance accrues to: modified-increased, decreased and zero-gravitation; the scarcity of sensory impressions, or sensory deprivation, sensory inadequacy, or sometimes its unusualness and excess; isolated state and confinement in a small space: novelty and unexpectedness of situations in which the cosmonauts find themselves in various flight stages; the boredom and continuous contact between participants in the space flight; the appreciable and continually increasing separation of the cosmonauts from large human groups; the differing (as compared with the Earth conditions) so-called time cues, i.e. agents signalling the start of given periods of days, primarily work and rest periods and, finally, the unusual combinations and unusual intensities and duration of the effect of a number of factors also occurring under ordinary conditions of man's life (noise, vibration, radioactive radiation, temperature fluctuations, etc.) (Author)

6. ALTUKHOV, G.V., P.V. VASIL'EV, V.E. BELAI and A.D. EGOROV. 1965. Diurnal rhythm of autonomic functions in cosmic flight. Izv. Akad. Nauk SSSR Ser. Biol., (Moscow) 30(2):182-187.

Changes in the rate of cardiac contractions and in the systolic index in the course of the day are analyzed and considered as an indication of the state of the cardiovascular system and the body as a whole. The data are based on observations made on four Soviet cosmonauts during preflight and orbital flight periods. Diurnal changes in the pulse rate and the systolic index were evaluated by mathematical analysis of corresponding observations under identical circumstances. Changes in the diurnal rhythm of certain autonomic functions were observed during periods of prolonged weightlessness. The mechanism responsible for these changes is thought to be connected with weightlessness specifically and with nervous and emotional tension. (I.A.A.)

7. ALTUKHOV, G.V., P.V. VASIL'EV, V.E. BELAI and A.D. EGOROV. 1968. (Diurnal rhythm of sympathetic functions during space flight.) Sutochnaia ritmika vegetativnykh funktsii v kosmicheskom polete. In: V.V. Parin and I.I. Kas'ian, eds. Mediko-Biologicheskie Issledovaniia v Nevesomosti. Moscow, Izdatel'stvo Meditsina. p. 201-205.

A study was made of the heart rate and systaltic index of cosmonauts Nikolaev, Popovich, Bykovskii, and Tereshkova during their group flight. It was considered that the heart rate represents the integral response of the organism to the effect of various factors in the external environment and that the systaltic index reflects the functional state of the myocardium. The recorded data were statistically processed and presented in graphic form. Unfortunately, the effects of space flight on these cosmonauts did not produce any uniform changes in the indices under study, and no definite conclusion could be drawn regarding the effects of weightlessness or other space-flight factors on cardiac functions. It was found, however, that the average heart rate tended to be slightly lower during flight. It was concluded that irregular changes in diurnal rhythms of sympathetic functions do occur during prolonged exposure to weightlessness and that the mechanism of these changes, while complex, is related to the effects of weightlessness and of nervous and emotional tension. (I.A.A.)

8. ANDREZHEVUK, N.I., et al. 1968. Effects of different work and rest routines on subjects kept in relative isolation. In: V.V. Parin and I.M. Khazen, eds. Selected translations from Aerospace Med. *Joint Publications Research Service, Washington, D.C.* pp. 52-63.

Two 15-day experiments were conducted on three subjects in an airtight chamber. The first experiment assessed the reactions produced by a routine involving 8 hours of sleep and 16 hours of wakefulness for each person. One month after its completion, the second experiment with the same subjects was conducted. The men slept for 6 hours, stayed on watch for the same length of time and spent the same number of hours in rest and self-service. The results show (1) In general, the 24-hour routine

was favorable. The main physiological functions underwent shallow changes characteristically found in people confined to a small, airtight place (2) More significant changes occurred with the 18-hour cycle where the routines were much different both in duration and in alternation of work and rest periods. The after-effects were more persistent than those which followed the first experiment (3) The biochemical tests and saliva lysozyme activity signified an endocrine and immunoreactive reconstruction of functions and the development of nervous and emotion strain, expecially in the 18-hour cycle experiment. (M.G.J.)

9. ANONYMOUS. 1965.
Light and dark may help man adjust to jet flight.
Science News Letter 88:24.

10. APFELBAUM, M., A. REINBERG, R. NILLUS, and F. HALBERG. 1969.
(Circadian rhythms of sleep-wakefulness alternation in seven young women during underground isolation.) Rythmes circadiens de l'alternance veille-sommeil pendant l'isolement souterrain de sept jeunes femmes.
Presse Med. 77(24):879-882.

Seven women volunteers, aged 20 to 35 years, spent 15 days in a cave 100 meters underground and 1,000 meters from the entrance. Neither sound nor light penetrated their camping place from outside the cave. The subjects were effectively deprived of all temporal information (date and local time) during 14 days. The variation of the environmental temperature (11 C.) and humidity (98 percent) was negligible. The subjects lived in 2 tents, 3 in one, 4 in the other, located about one meter apart. The subjects were able to communicate by telephone to the surface such information as moment of retiring and awakening. In addition, microphones had been placed in the cave which were continuously monitored by the surface personnel. Data were analyzed in a computer by a least squares spectral program showing circadian periods, acrophases or peak values, and time relationships in the sleep-wakefulness cycle. Paired acrophase and amplitude values were evaluated by cosinors and phase tests not weighted by the amplitude. It was shown that the circadian sleep-wakefulness rhythm persisted in each subject but with a period desynchronized from the 24-hour solar day but not with statistical significance from the lunar day. There were relatively small differences in the acrophases in the 7 subjects but the subgroups of 4 and 3 subjects who lived in the same tent throughout the experiment showed a small but significant difference in their acrophase, suggesting a social factor synchronizing their rhythm during the isolation. (A.R.T.)

11. ARDUINI, A., et al. 1964.
Desynchronization of the EEG and corticifugal activity.
Rivista di Patalogia Nervosa e Mentale 85:105-115.

12. ASCHOFF, J. 1967.
Adaptive cycles - their significance for defining environmental hazards.
Int. J. Biometerol. 11(3):255-278.

Discussion of the range and properties of biological rhythms, particularly circadian rhythms. Among the great variety of biological rhythms with

frequencies ranging from less than 1 per millisecond to 1 per several years, there are four rhythms which represent adaptations to time structures of the environment. These are the tidal, diurnal, lunar, and seasonal rhythms. Using the diurnal or circadian rhythm as the most extensively studied sample, the following aspects are described: (1) the properties of biological, self-sustained oscillators under constant conditions, as well as under the influence of a synchronizing environmental rhythm; (2) the multiplicity of rhythmic functions in an organism, especially those of sensitivity to external stimuli; and (3) case of internal desynchronization in man. Rhythms with lower frequencies are briefly mentioned, and the problem of defining environmental hazards with regard to temporal organization in the environment is discussed. (I.A.A.)

13. ASCHOFF, J., E. POPPEL and R. WEVER. 1969.
(Circadian rhythm in man under the effect of light-dark cycles of different periods.) Circadiane periodik des menschen unter dem einfluss von licht-dunkel wechseln unterschiedlicher periode.
Pflugers Archiv 306(1): 58-70.

Study of the circadian rhythms of ten subjects for different artificial light-dark cycles including twilight transitions. The zeitgeber was changed to periods either longer or shorter than 24 hours. It is shown that an artificial light-dark cycle synchronizes circadian rhythms in man only to periods which are close to 24 hours. For the activity rhythm, this range of entrainment is larger than for the temperature rhythm. The results establish the endogeneous character of human circadian rhythms using means other than the demonstration of free-running rhythms after the exclusion of zeitgebers. The finding that the rhythms of activity and of rectal temperature can vary independently, suggests that the two rhythms have to be considered as separate oscillators. (Z.W.)

14. ASCHOFF, J. 1969.
Desynchronization and resynchronization of human circadian rhythms.
Aerosp. Med. 40(8):844-849.

Using artificial synchronizing factors ("Zeitgeber") in the environment, it is possible to desynchronize the circadian rhythms from the periodicity of the natural environment; this is external desynchronization. In internal desynchronization, several rhythmic functions within the organism show different periods. A sudden transfer of the oranism east or west in space, as in a transoceanic air flight, is a phase-shift of external environment that is accompanied by an internal desynchronization during a few days. A subject confined for 24 days in a sound-proof bunker continued to show rhythms in wakefulness and sleep, body temperatures, and urine excretion but the sleep times drifted steadily toward later hours each day showing a periodicity greater than 24 hours. However, concurrent with each activity-time, there was a maximum in body temperature and in urinary excretion of potassium, sodium, and water. Thus, although desynchronized from the natural day-night cycle, the organism was still internally synchronized, all functions showing the same periodicity of about 24.9 hours. In a second experiment, upon release from the underground bunker the subject was out of phase with local time by about 6 hours. This difference was nearly fully corrected, as regards the wakefulness cycle, the next day but the rhythm of body temperature did not regain its normal phase until the

eighth day. Phase-angle difference could be changed in subjects whose rhythms were entrained to an artificial 26.7 hour day and resynchronization resulted when exposed to a 22.7 hour day. (A.R.T.)

15. ASCHOFF, J. 1967.
Desynchronization and resynchronization of human circadian rhythms.
In: AGARD, Behavioral Problems in Aerospace Medicine.

Circadian rhythms of activity, body temperature, and urine excretion have been measured in human subjects kept in isolation in an underground bunker, either in constant conditions or exposed to artificial light-dark cycles. In constant conditions, free-running rhythms synchronous in all functions have been demonstrated as well as cases with internal desynchronization. Entrainment to a 26.7 hour day resulted in changes of phase-angle differences as predicted from oscillation theory, whereas exposure to a 22.7 hour day resulted in relative coordination between the circadian rhythms and the light-dark cycle only. A group of four subjects, enclosed together into the bunker, showed synchronous circadian rhythms during the first 10 days, thereafter desynchronization between one subject and the rest of the group. Shifts of the artificial light-dark cycle by 6 hours, simulating flights in either eastward or westward direction, were followed by the activity-cycles of the subjects rather immediately; the rhythms of body temperature, however, did not regain their normal phases until seven days (up to 10) had elapsed. (Author) STAR

16. ASCHOFF, J., U. GERECKE and R. WEVER. 1967.
Desynchronization of human circadian rhythms.
Jap. J. Physiol. 17(4):450-457.

Fifty human subjects were kept in an underground bunker in conditions of continuous illumination, each in complete isolation and without any time-telling device. Rectal temperature was recorded continuously by means of an electric thermometer, and urine samples, collected in intervals of the subjects own choice, were analyzed for excretion of water, Na, Ca and K. Several systems of electric contacts served to survey the subjects general activities. All subjects showed free-running circadian rhythms, the average periods of wakefulness and sleep ranging from 23.9 to 50.0 hours. Thirty-six subjects remained internally synchronized during the whole experiment. In 5 cases, the rhythm of activity and the rhythms of vegetative functions were synchronized in a 1:2 ratio for parts of the experiment. Nine showed different circadian frequencies in activity and in body temperature; in two, desynchronization started immediately after being enclosed, in the remaining 7 subjects after 9 to 23 days of confinement. (Authors)

17. ASCHOFF, J. 1967.
Human circadian rhythms in activity, body temperature and other functions.
In: A.H. Brown and F.G. Favorite, eds. Life Sciences and Space Research V. Amsterdam, North-Holland Publishing Co. p. 159-173.

From earlier studies in the field of 24-hour rhythms, it has been concluded that the rhythm is an exogenous one, governed by social influences on behavior and, perhaps, by cosmic stimuli. Recently, new steps have been made in two directions: (1) the phase relationships between

many rhythmic functions have been described in detail, and (2) it has been demonstrated that the rhythm is based on an endogenous, self-sustained oscillation. In conditions of isolation, subjects show a "circadian" rhythm whose frequency deviates from that of the earth's rotation. In case of such free-running rhythms, it may happen that different functions show different frequencies (internal desychronization), suggesting that there exists a multiplicity of oscillators in the organism. The implications of these findings for problems in applied physiology are exemplified by the results of experiments in which organisms were exposed to shifts of the entraining light-dark cycle (simulating flights in eastward or westward direction). Re-entrainment lasts longer (and hence also the time of diminished efficiency) after a westward than after an eastward flight. (Author)

18. ASCHOFF, J. 1967.
(Phase relations between circadian periods of activity and human deep-body temperature.) Phasenbeziehungen zuischen den circadianen perioden der aktivitat und der kerntemperatur beim menschen.
Pflugers Archiv Gesamte Physiol. Menschen Tiere 295:173-183.

Investigation of the relation between periods of activity and rest in humans and their body temperature. For this purpose, rectal temperatures were taken on normally active or on resting subjects under the following conditions: (1) in an underground bunker at room temperature with constant illumination and exclusion of all known time indicators; (2) in the same bunker with a 12:12-hour light-dark cycle as the time indicator; and (3) in a climatic chamber with constant temperature, with the time of day known to the subjects and illumination at choice. The results suggest that the activity cycle and the temperature cycle be considered as two couple oscillators, whose phase-angle difference changes considerably when, after the exclusion of external time indicators, they start to oscillate with a spontaneous circadian frequency. (I.A.A.)

19. ASCHOFF, J. 1965.
Significance of circadian rhythms for space flight.
Southwest Res. Insti. Bioastron. and Explor. Space, pp. 465-484.

A discussion is given of the normal phase-relationship functions in the entrained organism and the significance of diurnal rhythms in sensory and motor performance. Also discussed are evidence for an endogenous rhythmicity in man, its characteristics and implications, and some of the problems of entrainment to unnatural Zeitgebers. Major topics considered include the phase map, self-sustained oscillation, conditions influencing frequency, internal desynchronization, the entrained circadian system, entrainment to a work-rest cycle, and features of entrainment. (C.T.C.)

20. ASCHOFF, J., and R. WEVER. 1962.
(Spontaneous periodicity in man under the exclusion of all time indicators.) Spontanperiodik des Menschen bei Ausschluss aller Zeitgeber.
Naturwissenschaften 49(15):337-342.

In an isolation experiment, nine subjects were confined to a self-contained cellar unit with complete exclusion of all time indicators. Each individual was allowed to set his own rhythm of sleep, activities, meals, etc. Physiological functions were monitored periodically. Subjective feelings were recorded in diary form or, when verbalized, on tape. During isolation, rhythms varied from 24.7 to 26.0 hours. Suggestions are offered for further research on the timing, desynchronization, and synchronization of endogenous rhythms in man.

21. ATKINSON, D.W., R.G. BORLAND and A.N. NICHOLSON. 1970.
Double crew continuous flying operations: A study of aircrew sleep patterns.
Aerospace Med. 41(10):1121-1126.

Continuous flying operations, in which crews sleep aboard the aircraft instead of sleeping at route stations, provide an operational capability independent of positioned crews. Such missions may lead to sleep difficulties and it is concluded form two missions operated by Royal Air Force Air Support Command that the optimum duration is 48 hours. In the case of a fast strategic transport aircraft this provides a world-wide capability.

22. BARHAD, B. and M. PAFNOTE. 1969.
(The socio-medical implications of shift work.) Implicatiile medico-sociale ale muncii in schimburi alternante.
Igiena 18(11):641-652.

Biologically, the difficulties arising from reversing the basic rhythm of the organism "vigil-sleep" could be attenuated or eliminated by installing an adaptation process, in the case of extended work in the same shift; socially, the individual's opportunities are restricted from fully participating in the social activities which are designed for daytime work. Medically, intolerance to shift work is manifested by gastric disturbances (in young workers) and nervous system upsets (in elderly workers). Special attention should be paid to detecting early symptoms of inadaptation. (B.G.)

23. BENEDICT, F.G. and J.F. SNELL. 1902.
Korpertemperatur-Schwankungen mit besonderer Rücksicht auf den Einfluss, welchen die Umkehrung der täglichen Lebensgewohnheit beim Menschen ausübt.
Pflueger's Archiv. 90:33-72.

24. BENEDICT, F.G. 1904.
Studies in body temperatures. I. Influence of the inversion of the daily routine; the temperature of night workers.
Amer. J. Physiol. 11:145-166.

25. BÉNITTE, A.C. and R.L. DES NOETTES. 1961.
Inversion of the nycthemeral rhythm. Its physiopathological consequences. Suggestions for an experimental study.
Rev. Méd. Aéron. 1(1):59-69.

Man is accustomed to a night-and-day alternating rhythm (nycthemeral rhythm) correlating sleep and waking states to the activity level of

major organic functions. This rhythm is not inborn. Experiments to alter the rhythm show that adaptation is possible. Rapid aircraft transportation across time belts creates cycle shifts which may cause inversion of the nycthemeral rhythm. Activity rhythms must adjust to new cycles. Eight to ten days is the average period required to begin a new rhythm. An experiment is presented for providing a more advanced analysis of adaptation mechanisms. (J.)

26. BÉNITTE, A.C. 1962.
(The concept of the "biological day". Practical considerations.)
La notion de "Jour biologique". Considerations pratiques.
Presse Therm. Climat. 99:138-140.

The principal difficulties which arise from the rapid crossing of time zones are disturbances of sleep, a true temporal disorientation, and digestive troubles. The importance of time in considering physiological functions is stressed. A fundamental property of living organisms in both the plant and animal kingdoms is the capability to appreciate the hours of the day to such an extent that the astronomic temporal day corresponds to a biological day. Vital phenomena as functions of time are of 2 types: One type is evolutionary, irreversible, as of the span of life itself. The others are periodic varying in length from a fraction of a second to many days or years (nervous impulses, pulse beats, states of wakefulness and sleep, activity and rest, sexual cycles). External excitations which essentially condition the periodicity of physiological functions are theoretically limitless: light, sound, electricity, heat, cold, known and unknown irradiations of all ranges and intensities. The organism makes a choice among these different stimuli, showing in this way its own antonomy. Circadian rhythms, adaptation by the organism to a changed time frame, and the effects of regular hours for therapy at spas are discussed. The biological day is characterized by nychthemeral rhythms, peculiar to each animal species, which in turn characterize the major biological functions of breathing, circulation, digestion, thermoregulation, cerebral activity, etc. (A.R.T.)

27. BÉNITTE, A.C. 1964.
(Nychthemeral rhythm and long-distance air travel.) Le rythme nycthéméral et les déplacements aeriens lontains.
Concours Medical 86(47):6603-6608.

Two types of vital phenomena may be distinguished as a function of time. Those of the one type are evolutionary, irreversible as the flowing of life itself. The others repeat themselves in an irregular or aperiodic manner, with a variable delay of renewal going from a fraction of a second to many days or years. These occur rhythmically or in cycles (nervous, impulses, cardiac beats, states of sleep and wakefulness, activity-response, sexual cycle, etc.). It is simple to observe a concordance between the rhythms of life on the one hand and, on the other, the alternations of days and nights, the succession of the seasons and even of geophysical cycles. Numerous functions or organs are subject to the variations of daily periodicity. The nychthemeral or circadian rhythms are conditioned by such external physical factors as light, sound, electricity, cold, heat, and known and unknown radiations. But in the wealth of these stimuli the organism retains only some of the signals. It makes a choice between these

different stimuli according to its needs or to shield against the dangers which their usage would represent. In such a way the organism shows its autonomy. The various circadian rhythms are discussed, including those of body temperature, heart beat, blood elements, renal function, hormonal levels, metabolism, cerebral activity, etc. Phase modifications of all these biologic rhythms occur in rapid air travel across several meridians of latitude. The most constant sign of an adjustment of the biologic clock to local clock time is the recuperation of sleep. From a practical viewpoint, the period of complete adaptation varies from 8 to 10 days for the totality of the biological rhythms. (A.R.T.)

28. BLATT, S.J. and D.M. QUINLAN. 1970.
The psychological effects of rapid shifts in temporal referents.
Studium Generale 23:533-549.

29. BLOOM, W. 1961.
Shift work and the sleep-wakefulness cycle.
Personnel 38(2):24-31.

30. BONJER, F.H. 1960.
Physiological aspects of shift work.
Proceedings of the 13th International Congress on Occupational Health. pp.79-80.

A study of the physiological aspects of different types of shift work showed no consistant difference in working capacity or productivity between the shifts. The diurnal rhythm of pulse rate and body temperature was studied by taking readings at 4-hour intervals in three subjects during a week of day shift, 13 weeks of continuous night shift and another week of day shift. A definite change in these diurnal patterns was demonstrated. This adaptation, however, proved to be lost completely after the weekly day off.

31. BORISOV, G.K. 1966.
(The dynamics of fatigue in railway dispatchers during night and day shifts.)
Dinamika utomlemya dispetcherov zheleznodorozhnogo transporta vo vremya dnevnykh i nochnykh dezhurstv.
Gigiena i Sanitariia 31(2):21-25.

A decrease of fatigue and a rise of the working capacity in railway dispatchers may be attained by shortening the time of shifts, by use of devices and apparatus facilitating the work, and by introduction of industrial physical exercises. The best time for performing industrial physical exercises is the period prior to excessive strain, i.e. during day shifts on the 6th and 9th hour of work and at night - on the 9th hour. Besides, in order to improve the functional state physical exercises should be performed before the night shifts. (Author)

32. BROWN, F.A. 1962.
Biological Clocks.
AIBS BSCS Pamphlet #2. p. 17.
Boston, Heath and Co.

33. BROWN, F.A., Jr. 1964.
The biological rhythm problem and its bearing on space biology.
In: W.C. Kaufman, ed. Bioastronautics - Fundamental and Practical Problems. North Hollywood, Western Periodicals Co. p. 29-39.

Discussion of the possible persistence of solar-day, lunar-day, monthly, and annual rhythms of animal and plant rhythmic systems under unvarying conditions of all ordinarily controlled environmental factors. Under such controlled conditions a duplex rhythmic state exists: (1) adaptive, adjustable rhythmic patterns modifiable by such factors as light, temperature, and feeding schedules and (2) geophysically dependent rhythmic variations resulting from continuous organismic response to normally uncontrolled residual physical rhythms. The significance of the rhythmic phenomena for space biology hinges importantly upon still unresolved problems. The question is asked whether the biological rhythms are the indispensable integrating clocks for life that they appear to be and if so, whether the timing system of the rhythms depends upon response to weak geophysical rhythms. The demonstrated existence of the geophysically dependent rhythmic component, together with the recently proven, extraordinary sensitivities of living creatures to the Earth's very weak magnetic, electric, and radiation fields raises the question of how far, and for how long, weak fields such as these can deviate in strength from their natural values without deleterious effects. (F.R.I.)

34. BROWN, W.K., J.D. ROGGE, J.F. MEYER, C.J. BUCKLEY, and C.A. BROWN. 1969. Aeromedical aspects of the first nonstop transatlantic helicopter flight. II-Heart rate and ECG changes.
Aerospace Medicine 40:714-717.

Electrocardiographic data were recorded continuously on three crew members during a 30-hour transatlantic flight in an H-3 helicopter. Heart rate changes during the flight were compared with control heart rates during routine daily activities. Changes in heart rates during flight indicated that there were significant periods of rest. The marked increases in heart rate (associated with obvious stressful events such as air refueling) indicate that heart rate may be a good index of acute stress. However, the lack of change in mean heart rate over control values in two of the three crew members indicated that either the stress was less than expected or heart rate does not adequately reflect prolonged stress. (Author)

35. Bruener, H., et al. 1964.
Fatigue-studies on oversea flights - A preliminary report.
International Congress on Aeronautic and Space Medicine, 13th, Dublin, Ireland.

Report on the preliminary results of a study of the fatigue effects of regular flights from Frankfurt to New York and vice versa on 4 crew members (pilot, copilot, engineer, and hostess) of a jet airliner. A "circulatory index" incorporating pulse rate, pulse pressure and systolic pulse pressure, compared with that of a control group performing comparable off-flight operations, is used to measure the fatigue. A diagram of index fluctuations during New York flights, a 24-hour rest there, and return flights to Frankfurt is plotted. The diagram, showing a depression of the index after flight and its partial recovery during rest, is briefly discussed. (Cir. Rhy. Bibl. by Heller)

36. BRUENER, H., K.E. KLEIN, S. RUFF, and H.M. WEGEMANN. 1965.
Fatigue-studies on overseas flight.
Aerospace Med. 36:552-553.

Studies were made on aircrew personnel during transatlantic flights from Frankfurt to New York and return. We found a "natural" depression of the circulatory parameters in the diurnal fluctuation during the night hours. It is probably caused by vagotonia. A depression found after long hours of mental work should have the same cause: a relative vagotonia, and should be an expression of a relative state of fatigue. This interpretation would best explain and also agree with the results we obtained with other physiological parameters. However, the practical significance of this conclusion is not within the field of study of this report.

37. BRYANT, S.W. 1963.
What jet travel does to your metabolic clock.
Fortune 68(5):160-163, 183-186.

Subsonic travel, east to west or west to east, across time zones poses special problems in fatigue. Recommendations are being made that executives not schedule conferences immediately after long flights. The core of the problem is that, with rapid change in time and environment, man's metabolic clock gets out of phase. The metabolic clock may be defined as the sum of the numerous bodily rhythms and cycles. These cycles have never been fully tabulated. Chief among them are circadian or twenty-four-hour rhythms: sleep and wakefulness, mental alertness, visceral activity, adrenal-gland activity, and variations in body pulse and temperature. Nine major cycles include: body temperature, blood circulation, breathing, liver activity, stomach and intestines, kidney, nervous system, blood composition, tissues. When all are synchronized the body is in tune with its environment. When the cycles are thrown out of synchronization, the body does not function at its best level. Fortunately for the jet traveler, the more important cycles readjust within a few days. Current controversies in cycle research concern the question of internal vs. external regulators. Current research activities in the area of travel adjustment are described. (Author)

38. BUCKLEY, C.J., and B.O. HARTMAN. 1969.
Aeromedical aspects of the first nonstop transatlantic helicopter flight. I--General mission overview and subjective fatigue analyses.
Aerosp. Med. 40:710-713.

Study of the effects of stress and fatigue on aircrew members participating in the first nonstop transatlantic helicopter flight. A general mission narrative and observations of the flight surgeon (crew member) are presented together with results of subjective fatigue rating, sleep pattern survey studies, continuous electrocardiographic recordings, and the analyses of altered excretion patterns of urinary constituents commonly effected by stress and/or fatigue. Results indicate that satisfactory aircrew performance can be maintained when helicopter crew members are exposed to the levels of stress and fatigue which were encountered on this record duration helicopter flight. (Author)

39. BUGARD, P. 1961.
(Hormonal and metabolic study of fatigue. II. Personnel flying aboard intercontinental airplanes.) Étude hormonale et métabolique de la fatigue. II. Personnel volant a bord d'avions interconinentaux.
Ann. Endocrinol. 22:1008-1016.

A study was made of 11 flight crews of Boeing 707 jets and 2 crews of 4-motor conventional aircraft (DC-6 and DC-7) engaged in intercontinental flights or similar distances on the Paris-Abidjan (Ivory Coast) route in conventional 4-motor planes. The findings included: 1) a hyperaldosteronism in 7 of 8 subjects tested and an inverse relation between the urinary Na/K ratio and aldosterone level; 2) a lowering of 17-ketosteroids during the flight, particularly in jets, in men but not in the women (hostesses); 3) an increase of 17-hydroxycorticosteroids (17-OHCS) and of creatinine under the same conditions. These reactions varied with the type of aircraft, from one flight to another, and from one subject to another. Such endocrine-metabolic studies may serve as a procedure for early detection of fatigue of the aviator. The most marked biologic reactions among male crew members were presented by the aircraft commanders as shown by more psychic and somatic tension: blood sodium was higher, diuresis and Na/K ratio were lower, and urinary 17-ketosteroids, 17-OHCS, and creatinine were higher than in other male crew members. (S.R.T.)

40. BUGARD, P., and M. HENRY. 1961.
(Some aspects of fatigue in air travel.) Quelques aspects de la fatigue dans l'aviation de transport.
Presse Med. 69(44):1903-1906.

The problem of aviator fatigue, a matter of concern since the beginning of aviation has taken on new dimensions with the advent of intercontinental high-speed jet travel because air crews are subjected to dislocations of physiologic rhythms in rapid crossing of many time zones and in opposing climates. This paper is concerned with 3 considerations: the syndrome of hyperaldosteronism; modification of the corticoids, particularly the urinary excretion of 17-ketosteroids (17-KS), 17-hydroxycorticosteroids (17-OHCS), and creatinine; and neuromuscular excitability, all of which constitute elements of a total physiopathology of the personality of the aviator at grips with new aggressive conditions. Hyperaldosteronism is brought on by the heat in the cockpit, emotional tension, and muscular fatigue; it is characterized by a diminution of diuresis and an intense thirst during the flight, a parallel slight diminution of total protein in the blood, of the hematocfit and of the red blood count at the end of the return flight, and a lowering of the excretion of sodium, of the urinary sodium-potassium ratio, and of blood potassium, and an increase of blood sodium which is slight but significant during the flight. In the most fatiguing flights the 17-KS levels are lowered in the males while in female flight personnel the 17-KS level does not decrease but hypophyso-ovarian disturbances ensue and the circadian rhythm is upset. The correlation between augmented 17-OHCS and creatinine levels, and various aspects of neuromuscular excitability to electrical stimulation are discussed. (A.R.T.)

41. BULEY, L.E. 1970.
Experience with a physiologically-based formula for determining rest periods on long-distance air travel.
Aerosp. Med. 41(6):680-683.

Official long-distance air travel by staff members of ICAO on missions and home leave is considerable. Until 1966, rest periods en-route or at destination before active duty were predicated on arbitrary rule-of-thumb "maximum journey times". This system was conducive neither to optimum physiological adjustment of staff on commencing duty at remote locations and on return to Headquarters, nor to optimum staff/administration relationships. A formula, based on significant, easily-quantifiable stress factors (but necessarily compromising between scientific accuracy and administrative expediency) was therefore developed and has been applied to all official ICAO air travel since January 1967: Rest period (in tenths of days) = Travel duration (in hours)/2 + Time zone differential in excess of 4, + Departure time coeff., + Arrival time coeff. (Departure and arrival time coefficients, which are related to local time, are read from a table.) The qualitative and quantitative rationale of the formula is described and ICAO's experience with it, in terms of efficiency and wellbeing of travelling staff and of administrative acceptability, is reviewed. Other organizations which have shown an interest in applying it to their diverse needs are mentioned.

42. BURCKHARD, E. and C. KAYSER. 1947.
L'inversion du rhythme nychthemeral de la temperature chez l'homme.
Compte Rendu 141:1265-1268.

43. BURTON, A. 1956.
The clinical importance of the physiology of temperature regulation.
Canad. Med. Assoc. J. 75:715-720.

44. CHAPEK, A.V. 1969.
(Diurnal periodicity of the physiological functions of the organisms of flight personnel.) K voprosu o sutochnoi periodike fiziologicheskikh funktsii organizma u letnogo sostava.
Losm. Biol. Med. 3:30-35.

Study of the diurnal periodicity of the body temperature, heart beat rates, blood pressure, EKG, minute heart volume, higher nervous activity, motor activity during sleep, cardiovascular system, and visual analysor in a group of aircraft crew members who fly regularly west to east and vice versa through several time zones. It is found that the diurnal rhythm of most of these functions tends to correspond to the time zone of the permanent residence of the crew members. It is pointed out that recommendations concerning the working and leisure time of flight personnel were made on the basis of this study. (V.Z.)

45. CHATELIER, G., and A.P. GILBERT. 1969.
(Weightlessness - Its physiopathological effects.) La 'non-pesanteur'--Ses effets physiopathologiques.
Rev. Corps. Sante Armees 10:761-781.

Examination of the physiopathological effects of weightlessness, defined as the apparent absence of weight within a system. At present, it appears that no major difficulties may be expected. For short flights (up to 14 days), the selection and training of astronauts seems to be sufficient to counterbalance anticipated problems. For long flights, the total dislocation of the sleep-wake rhythm may create serious nutritional and behavioral problems. Further, lowering of skeletal calcium and muscular nitrogen content appears to be linear as a function of time. If no adaptation mechanism halts this elimination, there is a risk of osteoporosis and amyotrophia. It would therefore be desirable to establish partial gravity in a spacecraft intended for long voyages by imparting rotation to it. (F.R.L.)

46. CHEMIN, Ph. 1970.
(Biological problems posed by astronautics. Effects of disturbances of the biological rhythms.) Problemes biologiques poses par l'astronautique. Effects des perturbations des rythmes biologiques.
Biol. Med., Paris 59:18-28.

Biological problems posed by space flights may be grouped under three categories: 1) Those posed by the dynamics of flight - acceleration, deceleration, and weightlessness; 2) those related to the milieu traversed - ionizing radiation, and meteorites; and 3) Problems arising from the necessity of living in an air-tight cabin, and particularly the problem of organization even of the rhythm of life of the personnel during their sojourn in the space vehicle. Biologic rhythms are susceptible of being entrained or dephased by physical factors of the environment which play the role of "sychronizers." Studies of the physiological reactions of space crew members have shown that in spite of the unusual infringements inherent in the very particular factors of ambience of space flights, the human organism is capable of withstanding and habituating itself to a certain extent to them, taking into account the basic rhythm. Synchronizers play an important role in our life, assuming the permanence of our rhythms. In the conquest of interplanetary space, biological problems hold an important place and will contribute to this new stage of the march of humanity toward a mysterious but exciting destiny. (A.R.T.)

47. CHEMIN, Ph. 1969.
(Biological rhythm disorders during air and space travel.) Les troubles des rythmes biologiques en aviation et en cosmonautique.
Forces Aeriennes Francaises 24:329-344.

Discussion of disturbances in the biological rhythms of astronauts due to physical environmental factors. The difficulty of adaptation to new sleeping habits imposed by the U.S. space flights is discussed. It is pointed out that some astronauts sleep as soundly in orbit as they do on the earth. A low degree of alertness seems to exist under weightlessness conditions. Accounts of space flights point to the existence of a slight lowering in physical tone, and to a tendency to drowsiness and prolonged sleep resulting in distraction and errors. A break in the routine wakefulness-sleep cycle poses adaptation problems. (M.M.)

48. CHEMIN, Ph. 1968.
(Biologic rhythms in aviation industrial medicine.) Les rythmes biologiques en medecine du travail aerien.
Arch. Mal. Prof. Med. Trav. Sec. Soc. 29(12):735-739.

Conditions of life of pilots (of long-distance aircraft) as of cosmonauts pose problems of the modification of biologic rhythms in general, these rhythms being susceptible of being entrained or dephased by physical factors of the environment, which play the role of synchronizers. First, some generalities on the rhythms are discussed to help explain the experimental observations. Circadian rhythms persist in the absence of known synchronizers but the role of synchronizers is considerable. A study of disturbances in aeronautical navigating personnel is described. Disturbances of sleep and of digestion occur in personnel after a jet flight across several time zones. The local clock time may indicate night while the internal physiological clock still indicates noon. Sleep is fitful and not restful. Nervous tension is increased and all factors together contribute to fatigue. The physiopathologic consequences of crossing many time zones rapidly probably will remain an important problem for flight crews for many years. In astronautics the same problems are encountered. In space flights, day and night lose their distinctive character and influence. Some of the physiopathologic implications of these facts are discussed. (A.R.T.)

49. CHEMIN, Ph. 1969.
(Biological rhythms in the course of space flights.) Les rhythms biologiques au cours des vols cosmonautiques.
Rech. Spatiale 8:16-22.

Study of the influence of biological rhythm perturbations on astronauts, especially perturbation of the waking-sleeping rhythm during space flights. Biological rhythms are discussed in general terms; they are endogenous and autonomous. The ways by which circadian rhythms convert physiological aspects into adaptation to the environment are outlined. Certain experiences of Soviet and American astronauts are described. The use of synchronizers is important under the exceptional conditions of outer space. While the nychthemeral rhythm need not be respected in its entirety by astronauts on short-duration flights, it is necessary, in the case of long flights, to conform scrupulously to the habitual terrestrial way of life. (I.A.A.)

50. CHEMIN, Ph. 1970.
Physiologic aspects of human acclimatization to extraterrestrial life conditions.
Arch. Mal. Prof. 31:375-380.

51. CHEMIN, Ph. 1969.
(Problems posed by the wake-sleep rhythm in the course of astronautical flights.) Problemes poses par le rythme veille-sommeil au cours des vols cosmonautiques.
Rev. Corps Sante Armees 10:575-584.

Discussion of the importance of organizing the waking and sleeping periods of spacecraft crews in order to ensure sufficient operational

capacity to maintain a constant watch and good operation of the spacecraft. It is also necessary to ensure a suitable life rhythm which does not involve physiopathological disorders. The importance of synchronizers on space flights of extended duration is shown. It is considered essential that man recreate the terrestrial time cycle in space. (F.R.L.)

52. CHEMIN, Ph. 1969.
(Psychologic reactions following disturbances of biologic rhythms during space flights.) Reactions psychologiques consecutives aux perturbations des rythmes biologiques au cours des vols cosmiques.
Ann. Med. Psychol. 127(2):227-232.

It has been shown that physiologic and psychologic phenomena are indissolubly linked in both normal and pathologic adaptations. The purely psychologic phenomena, such as attention, perception, fixation and retention of memory traces, obey the same laws as other manifestations of the biologic rhythms of temperature, sleep-wakefulness, etc. Experiments involving sensory deprivation are cited, in the laboratory and by isolation in caves. These confirm the existence in the organism of an internal clock synchronizer responsible for the activity rhythms of the individual. Experiments on isolation effects may have some analogy with conditions of life for the cosmonauts. These and space flight experiences show that man is able to adapt himself in a remarkable manner to unusual conditions of living; but it is still too early to tell if such adaptations could successfully be made in greatly prolonged space flights. Orbital flights made up to now have shown that the factors analyzed so far have been able to be surmounted by the cosmonauts, thanks to their training, motivation, and pioneering spirit. (A.R.T.)

53. CHEMIN, Ph. 1970.
(The sleep of the Cosmonauts. Neurophsyiological problems posed by astronautics. Influence of biological rhythms.) Le sommeil des Cosmonauts. Problemes neurophysiologiques poses par l'astronautique. Influence des rythmes biologiques.
Presse Med. 78(2):81-84.

The conditions of life of the Russian Cosmonauts in space posed the problem of equilibrium of biologic rhythms, which are susceptible of being entrained or dephased by physical factors of the environment which act as synchronizers. How does the sleep-wakefulness cycle react to these phase changes, in view of the ambient factors that are modified as is the case in astronautics? Autonomous or endogenous circadian or nychthemeral rhythms are influenced by synchronizers. If extra-physiological conditions do not create circadian rhythms, they are capable of modifying them. In cosmic flights of long duration, alteration of the system of synchronizers is inevitable as has already been shown by numerous experiences before space flights began. Research is cited concerning rhythm alterations in night workers, in animal experiments, and in isolated human subjects. The importance of biological rhythms in astronautics is discussed and the experiences reported from the (American) Gemini VII flight are cited. Conclusions are stated on the basis of the space flights of both Americans and Russians. Neurophysiological aspects of the biological rhythms must be taken into account in the space program. (A.R.T.)

54. COLIN, J., J. TIMBAL, C. BOUTELIER, Y. HOUDAS, and M. SIFFRE. 1968. Rhythm of the rectal temperature during a 6-month free-running experiment.
J. Appl. Physiol. 25(2):170-176.

Evidence from many sources indicates that the circadian rhythm of the central body temperature is not the simple consequence of the rhythm of activity. An experiment embodying a kind of partial sensory deprivation was devised to determine if the rhythm of central body temperature was dependent upon the rhythmic variations of the environment or was determined by an internal clockwork. A volunteer subject lived for 6 months in a cave where he was deprived of all time reference points and other known external synchronizers. The subject himself controlled his periods of activity, the darkness-light cycles, the feeding times, and the surrounding temperature within his tent in the cave. These are usually considered to be powerful external synchronizers but are not in this case because of their spontaneous selection by the subject. His deep rectal temperature was monitored during a period of 3 months and every half hour for as long as one month continuously. A circadian rhythm of activity was irregular and did not alter the rhythm of the temperature. There was a progressive lengthening of the period of the circadian rhythm of the rectal temperature, reaching 24 hours, 44 minutes during the last 4 months of the isolation. (A.R.T.)

55. COHEN, G. 1961.
What can be learned from disturbing the physiological clock of living organisms?
Nature (Paris) 89(3310):76-79.

56. COLQUHOUN, W.P., and R.S. EDWARDS. 1970.
Circadian rhythms of body temperature in shift-workers at a coalface.
Brit. J. Indus. Med. 27:266-272.

57. COLQUHOUN, W.P., M.J.F. BLAKE, and R.S. EDWARDS. 1968.
Experimental studies of shift-work. I: A comparison of 'rotating' and 'stabilized' 4-hour shift systems.
Ergonomics (London) 11(5):437-453.

Based upon the observation that, in general, performance follows the normal body-temperature rhythm and thus has been low at night when the temperature falls to its minimum value, a study was made of performance efficiency in workers on different shift systems to determine the correlation between performance and the circadian rhythm of body temperature when subjects are living and working under abnormal routines. Two work shift systems were used. The rotating system required the subjects to do mental work each 4-hour period of the 24 hours once every 72 hours in a repeating cycle. The stabilized work schedule included work periods from 12:30 to 4:30 P.M. and midnight to 4 A.M. In those subjects working the rotating system, fluctuations in efficiency appeared, in most cases, to be related to concurrent alterations in body temperatures resulting from its circadian rhythm. In general, efficiency scores were lowest between 2 and 8 A.M. and highest between 4 and 10 P.M. For subjects working the stabilized work schedule, temperatures over an extended

section of the 24-hour period were recorded one day before and again on the 12th or final day of the experiment. Comparison of the two sets of readings showed that the onset of temperature decline had shifted from about 9 P.M. to 2 A.M. thus showing a distinct shift in phasing of the temperature rhythm. The relationship between efficiency scores and concurrent temperature was relatively close though not as marked as in the rotating system. (A.R.T.)

58. COLQUHOUN, W.P., et al. 1968.
Experimental studies of shift-work. II. Stabilized 8-hour shift systems.
Ergonomics 11(6):527-546.

Thirty-one subjects were employed in an experiment to determine whether the relationship between efficiency at mental tasks and the circadian rhythm of body temperature observed in an earlier study was affected by an increase in the length of the duty spell from 4 to 8 hours. Subjects were assigned either to a control 'day' shift (0800-1600) a 'night' shift (2200-0600) or a 'morning' shift (0400-1200), and were tested for a period of 12 consecutive days on the same shift. The control shift-workers showed no consistent effects of fatigue due to the increased length of the duty spell. Adaptation of temperature rhythm to work on the night shift was only partial, but was relatively closely reflected in the recorded performance trends. Very little adaptation to work on the morning shift was observed, and performance was thought to have been affected by partial sleep deprivation. It was concluded that body temperature was as effective a predictor of overall mental efficiency in most industrial-type shifts as in the special 4-hour shift system previously investigated. (Author)

59. CONROY, R.T. 1969.
Circadian rhythms before and after a flight from India.
J. Physiol. 204:85P.

An Englishman flying from Delhi to Manchester (4-hour time shift) after a 2-month stay in India provided the following data: oral temperature every 2 hour, plasma 11-hydroxycorticosteroids (11-OHCS) four times during the waking day. Psychological tests comprising two cancellation tests (a simple perceptual-motor performance test) and a self-assessment inventory were performed after the blood samplings. The circadian rhythm of 11-OHCS and temperature before departure appeared to be adapted to local time, with maximal plasma 11-OHCS values in the early morning, and temperature maximum about 14.00 hours. Performance on the cancellation tests was best at midday which agreed with the subject's assessment that he was most active and least sleepy at that time. During the flight and for 5 days thereafter temperature fluctuated irregularly, but 10 days later it was re-adapted to English time. Steroid concentrations were low on the first and fourth days in England, but after 10 days the rhythm had returned to normal. Throughout the first 3 days in England performance on the cancellation tests was irregular, but on the fourth and fifth days it was approaching a normal pattern. The scores of activation and deactivation sleep immediately assumed the phase characteristic of English time, but for the first 2 days his maximum level of activation was low, and he was very sleepy for 3 days.

60. CONROY, R.T., A.L. ELLIOTT, and J.N. MILLS. 1970.
Circadian rhythms in plasma concentration of 11-hydroxycorticosteroids in men working on night shift and in permanent night workers.
Brit. J. Ind. Med. 27(2):170-174.

Blood samples were collected for estimation of plasma 11-hydroxy-corticosteroids from 3 groups of workers: day and night shift workers in a light engineering factory, and night workers in a newspaper printing works. Up to 5 samples were collected over 24 hours, or 2 samples 24 hours were collected for 3 days. Day workers showed maximal concentrations in the morning around the time when they started work. In the newspaper workers maximal concentrations were found when they awoke around 2 P.M. Night shift workers in the engineering works showed a greater variety of pattern, some showing the pattern usual in a day worker, some showing a maximum concentration about midnight and a minimum around 6 A.M. and a large proportion showing no clear circadian rhythm. In the newspaper workers the rhythm was thus well adapted to their pattern of nocturnal work, whereas relatively few of the night shift workers in the engineering works showed such adaptation. The adrenal cortical rhythm may be adapted to night work in a community in which this *is universal, accepted and lifelong, but such adjustment is unusual in* men on night shift work for limited periods, and whose associates are mainly following a usual nycthemeral existence.

61. CONROY, R.T., A.L. ELLIOTT, and J.N. MILLS. 1968.
Adaptation of physiological variables to time zone transitions.
J. Physiol. (London) 197:84P-85P.

Circadian rhythms in plasma corticosteroids and body temperature were observed in a young male subject making an east to west journey by sea involving a time-zone shift of 9 hours during a period of nearly two months(56 days), from the east coast of Australia to Capetown, South Africa. The rhythms were little, if any, disturbed, and it appeared that slow transitions across time zones during journeys by sea allowed gradual adaptation of circadian rhythms to occur. (A.R.T.)

62. CONROY, R.T., and M.D. HALL. 1969.
Adrenal cortical function and body temperature rhythms after a trans-atlantic flight.
J. Physiol. (London) 200:123P.

Body temperature and plasma 11-hydroxycorticosteroid (11-OHCS) rhythms were investigated in an adult female subject before and after an east to west airplane flight of nine hours involving a time-zone shift of 6 hours. Normal circadian rhythms of body temperature and plasma corticosteroids were observed prior to departure on the journey with a peak plasma 11-OHCS concentration in the morning and a nadir at midnight. Temperature rhythms were not fully adapted until the 11th day after the journey. The plasma 11-OHCS rhythm did not become fully adapted to local time until the 18th day. A prolonged disturbance in the periodicity of adrenal cortical function seems indicated. (A.R.T.)

63. CRANE, J.E. 1963.
The time zone fatigue syndrome.
Flying Physician 7:19-22.

64. DABNEY, W.M. 1966.
Asynchronosis: Infection by the virus of time.
J. Miss. State Med. Assn. 7(10):551-552.

Comparison is made of the physiological responses of individuals engaged in east-west travel by ship, by air, and by space vehicle. Only the tourist traveling by jet airplane experienced asynchronosis, because he could not take his time-oriented routing with him. Normally, readjustment can be made by the individuals whose travel schedules involve east-west itineraries that do not allow time for readjustment. The balance of individual systemic functions is disturbed, as are their interdependent relationships with one another. These disturbances do not occur in north-south jet travel which does not involve crossing time zones. When supersonic jets such as the British-French Concorde and the American SST, which can travel at speeds of 1,500 to 2,000 miles per hour, become operational, will it be possible to avoid the physiologic disturbances of asynchronosis resulting from 600 mph travel by conventional jet? The author postulates that it will be possible for flights of 2 hours duration or less because it would amount to little more than delay of lunch or an hour off schedule in getting to bed. The fallacy of this reasoning is that no matter how fast the plane flies, the absolute time in the respective time zones crossed does not change. (A.R.T.)

65. DAUBS, J.G. 1970.
Visual changes accompanying circadian rhythms desynchronization during circumnavigation of the Earth: A preliminary report.
Aerospace Medical Association Meeting, St. Louis, Mo., April 27-30, 1970, preprints. pp. 232-233.

66. DE LA MARE, G., and S. SHIMMIN. 1964.
Preferred patterns of duty in a flexible shift-working situation.
Occup. Psychol. 38:203-214.

Where real flexibility exists in a shift working situation it is possible to take actual working behavior as an indicator of preference. The clearly marked individual differences of preference were the result of many interrelated personal and environmental factors, including financial, social and domestic, personality and physical factors. The chief characteristic of the behavior patterns was the avoidance of mixed day and night working. Shift working inevitably involves the absence of a stable time framework within which the individual can order his activities, but changing between night and day working carries this instability to the extreme of a complete reversal of daily rhythms. It was this reversal of activity pattern which appeared to present the greatest difficulty in adaptation to continuous shift working.

67. DE LA MARE, G., and J. WALKER. 1965.
Shift working: the arrangement of hours on night work.
Nature (London) 208(5015):1127-1128.

Performance on some kinds of work can be affected by inversion of normal time routines so that output at night is lowest in the early hours of the morning. This is believed to be associated with diurnal rhythms which persist with old periodicities into the new routines. Two studies

of chemical plant workers on work-shifts of their own choosing (permanent day, permanent night, exchange shifts among themselves, 7-shift cycle, 3 x 2 x 2 cycle, alternate one night on, one night off) showed a biomodal distribution of preference for either permanent day or permanent night working. However, the variety of behavior observed in these investigations suggests that adaptation to shift working is a complex process involving the balancing of many factors in both the internal and external environment. Before theories of the optimum arrangement of shifts are formulated more must be known of the nature and interaction of psychological and social, as well as physiological, factors in the working situation.

68. DUSHKOV, B.A., A.N. ZOLOTUKHIN, A.V. KOROBKOV, and F.P. KOSMOLINSKII. 1969. (Effect of a "fractional" regime of daily activity on the human organism under conditions of relative isolation.) Vliianie na organizm cheloveka "drobnogo" rezhima sutochnoi deiatel'nosti v usloviiakh otnositel noi izoliatsii.
Kosm. Biol. Med. 3:35-40.

Study of the general conditions, cardiovascular system, neuromuscular activity, and mental fitness of a group of six subjects performing various physical assignment and mental tests according to prescribed activity/rest schedules during a seven-day confinement in a sealed chamber in a series of four experiments. The temperature ranged for 21 to 23.6 C, the humidity varied between 45 and 70%, the composition of the air was maintained within a hygienic standard, the noise level was not above 60 to 65 dB, and the illumination ranged from 150 to 170 lux. Suggestions are made as to how human adaptation to such conditions could be facilitated and the performance improved. (V.Z.)

69. DUSHKOV, B.A., et al. 1968.
Functional changes in man in chamber tests.
In: Selected Transl. from Aerospace Med. 28 Oct. 1968. pp. 64-72.

To assess the effects of simulated spaceflight conditions on nervous activity, motor, force and autonomic reactions, and emotional state, small airtight chambers were used in experiments on 80 males lasting from 12 hours to 70 days. Ordinary and altered daily routines were followed. The main objective was to detect deviations in the state of the functional systems and fluids, psychic functions, and efficiency. It was concluded: (1) Relative social isolation and sensory deprivation affected the nervous system, emotions, memory, and physical efficiency. No pathological changes were detected in mental activity. (2) As hypodynamia is indicated as one of the principal situational factors, careful attention should be paid to the physiology of activity in devising suitable motor tasks for the subjects. (3) Deep changes in the mental and physiological functions due to altered work and rest routines make it necessary to consider the question of biological rhythms in designing experiments of this kind. (M.G.J.)

70. DUSHKOV, B.A., ed. 1969.
Human motor activity in sealed chambers and during space flight.
Washington, D.C., Joint Publications Research Service, 18 May, 1970.

This book offers data concerning the comprehensive study of human motor activity in sealed chambers and during space flight. Particular atten-

tion is devoted to a complex of questions relating to the guidance of motor-coordinative activity given conditions of altered motor activity. Questions touching on changes in the coordination of movements, time intervals, and power reactions in connection with up-to-date data on the physiology of activity are considered. Quantitative characterizations of the stability of a highly-automatic motor act (walking) and specially-selected exercises in various positions during time spent in sealed chambers are discussed. A comparative physiological characterization is offered of the influence of a change in the supply of information in dependence upon the length of time spent in a small-volume chamber, as well as of the extent of the influence of unfavorable factors and individual character traits on the human organism under such circumstances. Scientifically-grounded recommendations are provided to solve a number of questions concerning the guidance of muscular activity and the regulation of movements under extreme conditions. (Author)

71. EBERHARD, J.W. 1966.
Sleep requirements and work-rest cycles for long term space missions. In: Human Factors Society National Convention, Anaheim, California, Nov. 1-4, 1966, Arlington, Va., Matrix Corporation.

This analysis tried to piece together data found in various industrial studies of the influence of sleep-wakefulness cycles on productivity, basic research studies applying physiological and psychological indices, results from space flight stimulation studies, and finally, the data released from the long term American space flights that have occurred to date. The review of the literature indicated: a) There seems to be inadequate data relating the application of earth-oriented sleep-wakefulness cycles in long-term space missions; b) The Gemini flights shift from a four-four schedule to one of eight hours tended to verify this for long-term missions; c) the 14 day Gemini 7 flight seems to indicate that an extended flight gradually requires less sleep; d) If mission oriented tasks require astronauts to perform on other than 8 hours consecutive sleep, consideration should be given to the effectiveness of different sleep periods from 2 angles: (1) selecting astronauts who require sufficiently less sleep, and (2) preconditioning the astronauts to use the different sleep-wakefulness cycle; e) More definitive work should be done on the area of split sleep schedules if such schedules should be required for future long-term space missions; and g) Consideration should be given to testing the period of wakefulness as related to the critical mission oriented tasks and astronaut performance of those mission oriented tasks to be performed upon sudden awakening. (Author)

72. ELLIOTT, A.L., J.N. MILLS, D.S. MINOR and I.M. WATERHOUSE. 1971.
Effects of simulated time zone shifts on plasma corticosteroid rhythms. J. Physiol. 217(1):50P-54P.

73. ELLIOTT, A.L., and J.N. MILLS. 1969.
Urinary potassium rhythms before and after transatlantic flight. J. Physiol. (London) 200(2):122P.

On the day after making an east to west airplane flight of 9 hours involving a time-zone shift of 6 hours, potassium excretion in 4 subjects

(3 adults, 1 child) was either nonrhythmic or had only partially adjusted its timing to the new zone. On the second day, excretion was rhythmic but the timing was not fully adapted. Full adaptation apparently had occurred after 5 days. Sleep rhythm in one adult subject adapted at about the same rate as the potassium excretory rhythm. (A.R.T.)

74. ERKINARO, EINO. 1969.
(The course of desynchronized circadian periodicity in a wood mouse [Apodemus flavicollis]in North Finland.) Der Verlauf desynchronisierter, circadianer Periodik einer Waldmaus [Apodemus flavicollis] in Nordfinnland.
Z.Vergl.Physiol. 64(4):407-410.

A free running circadian periodicity in the locomotive activity of a wood mouse (Apodemus flavicollis) was recorded 172 km south of the artic circle for 2 successive summers during natural day. The sensitivity of the animal to the pacemaker varied with the age under the same experimental conditions. The same mouse was desynchronized for 48 days in 1967, in 1968, 77 days. The time of desynchronization is not more that 6° below the horizon (Civil Twilight). Despite free running periodicity, day and night were perceived as variations in the conditions of continuous lighting. An activity period including a night was shortened, and lengthened when it included a day.

75. EVANS, J.I., G.A. CHRISTIE, S.A. LEWIS, J. DALY, and M. MOORE-ROBINSON. 1972.
Sleep and time zone changes. A study in acute sleep reversal.
Arch. Neurol. 26:36-48.

Alterations occurred in the overnight sleep patterns of four healthy male subjects before and after trans-Atlantic flights in both directions. On the first night after a London/San Francisco flight, stage 4 sleep was enhanced, and rapid eye movement (REM) sleep was depressed, although the distribution of both types of sleep during the night was not altered. Early morning waking was a feature of the first five nights in the new time zone, particularly in the older subjects. Similar changes occurred after the return flight. There was no evidence of enhancement of REM sleep and the alteration in the distribution of REM sleep which has been noted in laboratory studies of sleep reversal. However, the changes found were in accord with travellers' complaints. No definite evidence of circadian effects due to alteration in time zone was demonstrated.

76. FEIGEN, R.D., A.S. KLAINER and W.R. BEISEL. 1968.
Factors affecting circadian periodicity of blood amino acids in man.
Metabolism 17(9):764-775.

Total whole blood amino acids in normal men and all major individual blood amino acids (with the single exception of citrulline) were found to display a circadian periodicity characterized by peak values between 1200 and 2000 hours and lowest values between 0400 and 0800. Possible underlying factors responsible for this rhythm were investigated. Increases and decreases in the total protein content of an isocaloric diet did not affect amino acid periodicity. In addition, the

ingestion of a large protein load at 0800 hours, a time of rising whole blood amino acid concentration, resulted in a small but significant additional increase, whereas an identical protein load eaten at 2000 hours did not interfere with the decrease in amino acid concentration normally seen between 2000 and 0400 hours. An acute period of physical exercise did not affect blood amino acid concentrations. A 12-hour shift in the sleep-wakefulness cycle in normal adult males resulted in a rapid reversal of the normal circadian periodicity of blood amino acids, such that peak values were observed at 0400 hours, rather than at 1200 to 2000 hours as seen in subjects on a normal routine. The rhythmicity of blood amino acids could be dissociated from those of body temperature, urine volume and sodium and potassium excretion. These latter observations suggested that blood amino acid periodicity may be influenced significantly by exogenous synchronizers, although it is likely that the basic rhythms are generated by unknown endogenous signals.

77. FELDBERG, W., and R.D. MYERS. 1964.
Diurnal rhythms during three months underground.
J. Physiol. (London) 171(1):12P-13P.

Every week the subject collected all the urine produced during two sleep periods and the intervening day and recorded the volume and time of each voiding. Most of the series showed a cyclic variation in excretion of potassium, sodium, and chloride similar to the usual circadian rhythm, but the time of the peak excretion appeared to be progressively displaced. The cycle length varied randomly from week to week, between 23.5 and 25.6 hours, but the values estimated from chloride and potassium excretion were closely correlated for the first 8 weeks. Thereafter, the chloride cycle lengthened, becoming up to 7 hours out of phase with the potassium cycle, until after 11 weeks chloride excretion ceased to show any circadian rhythm. Potassium excretion remained rhythmic during the whole stay underground, with an overall mean cycle length of 24.56 hours. The progressively displaced rhythmicity of the sleep/wake cycle was very similar to that affecting the kidneys.

78. FISCHGOLD, H. 1969.
(Problems posed by sleep debt, reserve, and adaptation at the time of traversing time zones.) Problemes poses par la dette de sommeil, la reserve de sommeil et l'adaptation du sommeil lors de franchissement de fuseaux horaires. p. M1-4.
In: Reunion de Cronobiologie Appliquee a l'Hygiene de l'Environment. Fondation A de Rothschild, Paris

The sleep-wakefulness cycle is modulated in each animal species by its mode of life, its security and its means of defense. Man in temperate climates usually works by day and sleeps at night with the exception of those in certain occupations. No cerebral clock seems necessary to sleep after the fatigue of the day. However, the distribution of wakefulness and sleep in a 24-hour period changes with the age of the individual. In the nursling, the needs for feeding and changing constitute good non-solar clocks; but soon the infant adopts nocturnal repose. Do we need to recall the capacity of the adolescent for resisting sleep? One 17-year old went 11 days without sleep; but the adult is not able to contract a prolonged sleep deficit without damage to his social, psychic, sensory, and motor

behavior. Finally, we see the aged individual with his very light sleep, interrupted by lonely and uneasy awakenings. In a study of 18 subjects (members of airplane crews) it was found that, after flights crossing several time zones, they went to sleep more easily, and slept longer and more profoundly when they had a sleep deficit than without it. When flight crews can fly from Paris to New York and return on the same day, problems of interference with biologic rhythms disappear. (A.R.T.)

79. FLINK, E.B. and R.P. DOE. 1959.
Effect of sudden time displacement by air travel on synchronization of adrenal function.
Proc. Soc. Exp. Biol. Med. 100:498-501.

80. FORT, A. 1969.
The effects of rapid change in time zone on circadian variation in psychological functions.
J. Physiol. (London) 200:124P.

A simple cancellation test (perceptual motor performance), the Activation-Deactivation Adjective Check List (AD-ACL), the Fatigue Checklist, and the Deactivation-Sleep evaluation were self-administered by an adult female subject for 3 control days prior to making an east to west airplane flight of 9 hours involving a time-zone shift of 6 hours and for the first 4 days after arrival. She also tested herself for periods of 48 hours in each of the following three weeks. The usual testing times were: on arising, at noon, at 6 P.M. and before going to bed. The Fatigue Checklist score and the High Activation score on the AD-ACL were largely adapted after the first day at her destination following the flight. The Deactivation-Sleep score showed a slow change. The cancellation test showed that adaptation was sensibly complete by the fourth day. All the relevant self-report measures indicated that the subject felt very tired by evening during the four days following the flight, suggesting incomplete adaptation on any of them during this period. (A.R.T.)

81. GASSEL, M.M., B. GHELARDUCCI and P.L. MARCHIAFAVA, et al. 1964.
Phasic changes in blood pressure and heart rate during the rapid eye movement episodes of desynchronized sleep in unrestrained cats.
Arch. Ital. Biol. 102:530-544.

82. GERATHEWOHL, S.J. 1968.
(Space Biological Experiments of the Gemini Program, AAP [Apollo Application Program] and Apollo Extension System.) Biologische experimente im rahmen der programme Gemini, AAP [Apollo Application Program] und Apollo Extension System.
Space Biol. and Biophys., pp. 9-24.

The author outlines scientific concepts, hypotheses, and assumptions that form the bases for the biological extraterrestrial and biophysical research programs of NASA. Covered are life science experiments during manned space flight missions as well as work in manned oribiting laboratories. Described are biological experiments to investigate weightlessness, ionizing radiation, effects of vacuum, and synergetic effects of space on biological rhythms. Geobiological investigations of plant and animal global distributions, their dependency and transformations caused by geophysical factors are correlated with changes in earth surface properties and biological ecology by global statistics. (G.G.)

83. GERRITZEN, F. 1962.
The diurnal rhythm in water, chloride, sodium and potassium excretion during a rapid displacement from east to west and vice versa.
Aerosp. Med. 33:697-701.

A study was made to ascertain the time required for the maximum of the diurnal rhythm to adapt to local time after a jet airplane flight from Amsterdam to New York (a difference of 5 time zones) as well as a similar flight from New York to Amsterdam. Two healthy adult males made the east-west flight and remained in New York for 4 days before returning to Amsterdam in one experiment. In another, they made a round trip flight remaining in New York only 2 hours. The maximum in water, chloride, sodium and potassium excretion occurred at about 2 P.M. on several days before the flights began. Two disturbances of normal rhythm were seen after the east-west flight: there was a diminution in the amplitude of the rhythm in the excretion of water and the electrolytes and there was a discongruence between the time of the endogenous maximum of the subjects and the local time which lasted for at least 4 days before the maximum had adjusted or almost adjusted to the local time. On the return flight (west-east) the adjustment was completed sooner. Results are presented graphically.

84. GERRITZEN, F. 1966.
Influence of light on human circadian rhythms.
Aerosp. Med. 37:66-70.

The influence of light on the rhythmic excretion of water and electrolytes was studied in 4 groups of 5 healthy students under strict experimental conditions - hourly intake of food and fluid, hourly collection of the urine - during 47 to 62 hours. Inverse illumination resulted in a decrease of the amplitude and a reversal of maxima and minima. This procedure was not able to produce a maximum of certain magnitude on a different place in the cycle. In a fifth experiment a shorter period of darkness proved to be incapable of depressing the amplitude. Light was considered an unsuitable stimulus to shorten the period of adaptation after rapid flights in the East-West direction or vice versa. Induction of artificial sleep might be more appropriate. The significance of circadian rhythms in connection with our conception of the stability of the 'milieu interieur' is discussed. (Author)

85. GERRITZEN, F. 1969.
Methods for the study of the behavior of human circadian rhythms in kidney function before, during and after global flights.
In: International Congress of Aerospace Medicine, 18th, Amsterdam, Netherlands, September 15-18, 1969. pp. 81-82.

Specification of the urine sampling conditions which facilitate the obtaining of reliable results in studying the circadian rhythm of the kidney function during global flights. The conditions concern food and water intake by the subjects, sampling intervals, and the body position. The possible causes of the inconsistancies in the circadian rhythm results obtained during several intercontinental flights are discussed.

86. GERRITZEN, F., T. STRENGERS, and S. ESSER. 1969.
Studies on the influence of fast transportation on the circadian excretion pattern of the kidney in humans.
Aerosp. Med. 40:264-271.

Study of the effect of rapid global transportation on the circadian rhythmic patterns in human body functions, with particular attention to kidney excretion. Analysis of the data confirms the homeostatic character of the rhythmic behavior of the body functions, and indicates that the pituitary adrenal cortical system is of major importance in the maintenance of the circadian rhythm. (B.H.)

87. GHATA, J., F. HALBERG, A. REINBERG, and M. SIFFRE. 1969.
(Desynchronized circadian rhythms of the social cycle [17-hydroxycorticosteroids, rectal temperature, sleep-wakefulness] in two healthy adult subjects.) Rhythmes circadiens desynchronises du cycle social [17-hydroxycorticosteroides, temperture rectale, veille-sommeil] chez deux sujets adultes sains.
Ann. Endocrinol. 30(2):245-260.

Circadian components of the urinary excretion of 17-hydroxycorticosteroids (17-OHCS), of rectal temperature, and of sleep were evaluated in two subjects: a) during isolation in a cave (without known synchronizers), and b) while synchronized by social cycles of light and darkness. The subjects, a man and a woman, were isolated for 125 and 88 days respectively in separate caves some 80 meters below the surface and thereafter spent 32 normal days in a normal hospital environment while the study of the circadian rhythms continued. Special electronic computer programs were used to analyze the data obtained. The circadain rhythms of 17-OHCS excretion and of rectal temperature persisted in the absence of known synchronizers but were desynchronized from local clock time. The peak values of 17-OHCS excretion, however, continued to precede those of the rectal temperature in isolation just as it did under conditions of social synchronization (before and after isolation).

88. GHATA, J. 1969.
(Physiologic effects of transmeridian flights.) Effets physiologiques de vols transmeridiens.
In: Reunion de Chronobiologie Appliquee a l'Hygiene de l'Environment. Fondation A de Rothschild, Paris, p. D1-5.

The techniques of chronobiologic analysis have been used to study the effects of long distance flights, east-west and north-south, and the data have been interpreted by the cosinor method of statistical analysis. Six-day flights from Paris to Brazzaville, to Johannesburg, and from Paris to Athens, to Colombo (Ceylon), to Sydney, Australia were involved in the study. The urinary elements studied every 4 hours included excretion of potassium, sodium, calcium, phosphorus, 17-hydroxycorticosteroids (17-OHCS), hydroxymethoxymandelic acid, and 5-hydroxyindoleacetic acid. Temperature and pulse were noted every 4 hours and at the same time two tests were given the subjects - one was to estimate the duration of a short period of time, and the other was to see how long it took to arrange a pack of playing cards. The results of some of the observations are presented in tabular

form. In the west-east flight (Paris to Sydney) only the urinary excretion of 5-hydroxyindoleacetic acid was elevated significantly. An inverted phase difference was noted in the excretion of 17-OHCS which rapidly disappeared upon return to Paris. In the north-south flight, only climatic factors possibly interfered with circadian variations.

89. GHATA, J., F. HALBERG, A. REINBERG, and M. SIFFRE. 1968. (Desynchronized circadian rhythms [17-hydroxycorticosteroids, rectal temperature, sleep-wakefulness] in two healthy adult subjects.) Rhythmes circadians desynchronises [17-hydroxycorticosteroides, temperature rectale, veille-sommeil] chez deux sujets adultes sains. Ann. Endocrinol. 29:269-270.

A man and a woman were studied while isolated in caves in the absence of any synchronizers. Computer analysis was made of the variables studied. The circadian rythms in urinary excretion of 17-hydroxycorticosteroids (17-OHCS) and in rectal temperature persisted but desynchronized significantly from local clock time. Under conditions of synchronization by societal stimuli or clues, it was found that the 24-hour cyclic societal routine can impose its cycle length on the rhythms. Resynchronization was demonstrated after prior spans of isolation associated with desynchronized rhythms. No mention is made of the sleep-wakefulness cycle in isolation or under societal stimuli. (A.R.T.)

90. GIBSON, R.B. 1905
The effects of transposition of the daily routine on the rhythm of temperature variation.
Amer. J. Med. Sci. 129:1048-1059.

91. GOMES, G.S. 1969.
Time zone and sports.
Rev. Brasil. Med. 26:708-710.

92. GRETER, W.F. 1965.
Human performance for military and civilian operations in space.
Ann. N.Y. Acad. Sci. 134:398-412.

Some of the research is reviewed concerning scientific and technical questions related to human activities in space. Included are such subjects as reduced gravity or weightlessness and human performance, movement and work both inside and outside the vehicle, human capabilities for prolonged periods in space, and visual capabilities in space. Confinement studies made in a simulator for 15 days on a schedule of 4 hours work and 2 hours rest and for 30 days of 4 hours work and 4 hours rest revealed the persistence of a 24-hour diurnal cycle in some of the data. The subjects had full knowledge of calendar and clock time, but were removed from the normal daily environmental influences. The circadian cycle showed most clearly in the heart rate and temperature records. Although not as clear, the diurnal cycle also appeared in some of the performance measures, particularly for subjects on a 4 hours work and 2 hours rest schedule, whose sleep time was marginal. Men on the less

rigorous 4 hours work and 4 hours rest schedule did not show the diurnal cycles in performance, although the cycles in physiological parameters were present under all conditions. (A.R.T.)

93. GRIGOR'EV, Y.G. and YU. FARBER. 1966.
Vestibular function in man during a 120-day period in a hermetically sealed chamber.
Fed. Proc. 25:966-968.

Examinations were made on five individuals between the ages of 19 and 32 after 2,3 and 4 months in a hermetically sealed chamber and on 3, 8, 18, and 33 days after the subjects emerged from the chambers. The fact that, at the end of the experiment, the changes in the nystagmus curve were similar in all cases suggests that conditions within the sealed chamber had a definite effect on the functional state of the vestibular system, as evidenced by the reduction of the angle of inclination of the nystagmus curve and reduction in the duration of nystagmus. The rise of the threshholds of the sensory component and fluctuations in the duration of nystagmus and in the angle of inclination of the nystagmus curves, observed after the subjects left the chamber, were probably connected with "re-adaptation" in response to change in the pattern of life and altered physical factors. The changes in vestibular function had no obvious effect on normal body activity.

94. GOUTTENÈGRE, C. 1963.
(Study of the 3x8 work schedule of the Electric and Gas Companies of France.) Étude sur le travail en 3x8 à Electricité et Gaz de France.
Arch. Mal. Prof. Med. Trav. 24:117-120.

A 3-year study was made of working conditions by physicians of the electric and gas industries. Some 115,000 workers are employed in these industries in France under the surveillance of 100 industrial physicians either full or part-time. During the study, 6,800 workers worked the 3x8 schedule in the two national services and 57 physicians actually took part in the research. Analysis was made of replies by the physicians to a 5-question inquiry about the observed effects on the workers of the 3x8 working schedule. The results showed that, physiologically, effects were noted due to irregularity of sleep and rest, and qualitative modifications of food intake; psychologically, there was disruption of familial life and social activities. These inconveniences were felt very differently by those involved depending on numerous factors such as rural or urban locale, distance from home to work, whether home was noisy or quiet, whether the worker was single or married, and if there were children or not. Some workers had to have work hours changed because of illness or aggravation of pathological conditions, including neuroses and psychosomatic difficulties. Changes in sleep rhythms before workers have time to adjust are deleterious. The effects of 3x8 work schedules on certain workers are predictable and will aggravate their troubles and their inability to adapt themselves, Morbidity increases among workers subjected to toxic atmospheres, excessive heat, dust, and heavy labor. Among these conditions, the hours of the work schedule may become an aggravating factor. (A.R.T.)

95. GROLL, E. and M. HAIDER. 1965.
Stress differences in female workers during early and late shifts.
Inter. Z. Angew. Physiol. 21:305-312.

96. GUBERAN, E., M.K. WILLIAMS, J. WALFORD and M.M. SMITH. 1969.
Circadian variation of F.E.V. in shift workers.
Brit. J. Indust. Med. 26:121-125.

A survey was carried out in a factory making plastic boxes and separators for car batteries among men who worked a rotating three-shift schedule of 2 to 10 P.M. one week, 10 P.M. to 6 A.M. the next week, and 6 A.M. to 2 P.M. the third week. Measurements were made before starting work, in the middle of the work period before the meal break, and at the end of the work period, on Mondays and Fridays of each shift period. The one-second forced expiratory volume (F.E.V.), the forced vital capacity (F.V.C.), and oral temperature were measured. The mean F.E.V. of the 19 normal men who participated in the study showed an increase of 4.1 percent at the end compared with the beginning of the 6 A.M. to 2 P.M. shift on both Monday and Friday; a mean decrease of 1.5 percent was found between the beginning and the end of the afternoon shift on both days; and little change was noted during the night shift. This circadian variation could not be attributed to a learning effect, to exposure to industrial fume or a hot humid environment, nor to smoking. The mean F.V.C. of the normal men varied in a similar manner to the F.E.V., showing a rise during the morning shifts, a fall during the afternoon shifts, and little change during the night shifts. There was some positive association between the mean F.E.V. and mean oral temperature on the morning and night shifts, but on the afternoon shifts the association tended to be negative. Significance of the findings is discussed. (A.R.T.)

97. GULLETT, C.C. 1966.
Jet planes and the circadian cycle.
J. Amer. Med. Ass. 197(11):213-214.

This reply to a question, in the Questions and Answers column of the Journal, deals with the shifting on one's activity pattern out of phase with the circadian cycle to which one has become accustomed. When one tries to sleep while the body is still physiologically awake or tries to remain active when physiologically ready for sleep produces a wide variety of sensations in many people. An in-phase shift of this diurnal cycle then takes place in 2 to 4 days and the symptoms cease. The questioner is referred to a special report on aircraft pilot fatigue. (A.R.T.)

98. GUROVSKIY, N.N., B.A. DUSHKOV and F.P. KOSMOLINSKIY. 1966.
Study of the work and rest cycles of test subjects exposed to relative isolation.
In: V.V. Parin, ed. Problems in Aerospace Medicine, p. 180-181. Washington, D.C., Joint Publications Research Service, 21 Oct. 1966. (transl. of Problemy Kosmicheskoy Meditsiny: Materialy Konferentsii, 1966). Avail: CFSTI (N67-11401).

Results of two 15-day experiments on three test subjects in a sealed chamber, with 24- and 18-hour rest and work cycles, are given. The 18-

hour cycle had a greater effect on psychic functions, cardiovascular system, nervous and muscular activity, and caused more pronounced biochemical changes, indicating the development of nervous and emotional stress. Objective and subjective observations on reaction of the organism to the two cycles are tabulated and plotted. (Author)

99. GUROVSKIY, N.N., B.A. DUSHKOV and F.P. KOSMOLINSKIY. 1966.
Study of regimes of vital activity of a group of test subjects in an isolation chamber.
In: V.V. Parin, ed. Problems in Aerospace Medicine, p. 180-181. Washington, D.C., Joint Publications Research Service, 21 Oct. 1966. (transl. of Problemy Kosmicheskoy Meditsiny: Materialy Konferentsii, 1966).
Avail: CFSTI (N67-11401)

Results of two 15-day isolation chamber experiments, with three persons participating in each, indicate that the more difficulty a person has in tolerating a regime, the more he will depart from his customary reactions. In one experiment, one test subject slept, the second rested, and the third was on watch when observations were made; with each individual alternating between eight hours of sleep and four hours of work. The second experiment employed a six-hour period of sleep, a three-hour period of duty, another six-hour sleep, and a three-hour period of relaxation. (M.W.R.)

100. HADENGUE, A., J.D. REYNAUD and A. REINBERG. 1963.
(The psychophysiological range of effects and the pathologic aspects of the apportionment of work hours.) Les incidences psycho-physiologiques et les aspects pathologiques de la repartition des horaires de travail.
Arch. Mal. Prof. Med. Trav. (Paris) 24(1-2-3):1-45.

A normal subject in good health who has a satisfactory physiologic and psychologic equilibrium is able to adapt without inconvenience to a work schedule of hours that is different from that to which the human organism is traditionally adapted, particularly to night work. However, capacity for such adaptation is variable among individuals and cannot be predicted. The duration of the period of adaptation varies among individuals from a few days to 2 or 3 weeks. It is desirable for the individual that changes in work shifts be made not oftener than from one to three months. Psychological considerations should not be ignored. Acceptance by the individual of nonconformity with the usual nychthemeral pattern of sleep-wakefulness is essential. Consideration of material advantages should not be preponderant. The pathology that is linked to the work-hour schedule arises generally more from the social context than from the work itself. Organic disequilibrium may result. The tasks of industrial medicine, including types of needed research, are discussed. (A.R.T.)

101. HALBERG, F. and A. REINBERG. 1967
(Circadian and low-frequency rhythms in human physiology.) Rythmes circadiens et rythmes de basses frequences en physiologie humaine.
J. Physiol. (Paris) 59(1 suppl.):117-200.

Several rhythms with middle and low-frequency, in man as well as in experimental organisms, are usually synchronized by cycle environmental routines. These same rhythms can clearly desynchronize from the environmental synchronizer and exhibit a τ that is slightly yet statistically significantly different from the precise environmental τ. This point is now documented for the circadian and also for the circaseptan rhythm of

man. The thus quantified broad spectrum of physiologic rhythms with different frequencies can tentatively be subdivided into: (1) A high frequency domain of rhythms with period (τ) shorter than 0.5 hr.; (2) A medial frequency domain of rhythms with τ ranging in length from 0.5 hr. to 2.5 days [including the regions of a) ultradian (0.5 hr$<\tau\leq$20 hr.), b) circadian (20 hr$<\tau\leq$ 28 hr.) and c) infradian (28 hr$<\tau\leq$ 2.5 days) rhythms]; and (3) A low frequency domain of rhythms with τ longer than 2.5 days: inter alia, circaseptan ($\tau\sim$7 days), circavigintan ($\tau\sim$20 days), circatrigintan ($\tau\sim$ 30 days), circannual ($\tau\sim$1 year) rhythms. (From author's summary)

102. HALBERG, F., C. VALLBONA, L.F. DIETLEIN, J.A. RUMMEL, C.A. BERRY, G.C. PITTS and S.A. NUNNELEY. 1970.
Human circadian circulatory rhythms during weightlessness in extra-terrestrial flight or bedrest with or without exercise.
Space Life Sciences 2(1):18-32.

Human circadian rhythms are detected in heart rate and in the durations of electromechanical systole and of the entire cardiac cycle by an inferential statistical analysis , the cosinor method, carried out rapidly by computer. These findings apply to men on earth in bed for several days-whether or not they intermittently carry out isometric exercise. Rhythms also are demonstrated in men at a few hundred nautical miles from earth experiencing weightlessness for several days during extra-terrestrial space flight; whether or not these circadian rhythms are 24-hr synchronized cannot be discussed with the data on hand. Such demonstrations of rhythm persistence in astronauts and cosmonauts underline the need for further work on mammals to define and to control those rhythmic factors affecting not only the longer-term scheduling of human activities in extraterrestrial space but also rhythmic behavior in health and disease on earth. The implementation of such studies by rigorous circadian and other parameter estimations carried out on earth remains a sine qua non at first; yet given such background information, the long-term behavior of rhythms in organisms transferred to terrestrial, lunar and, eventually, solar orbits remains a major challenge to the United States space program for research in extraterrestrial space as well as a fertile ground for future international cooperation, involving as it does phenomena directly related to human performance and resistance. (G.A.H.)

103. HALBERG, F., P.G. ALBRECHT and C.P. BARNUM, Jr. 1960.
Phase shifting of liver-glycogen rhythm in intact mice.
Am. J. Physiol. 199(3):400-402.

After the abrupt inversion of a regimen providing for alternating 12 hours of light and darkness the liver-glycogen rhythm of mice feeding ad libitum shifted gradually, rather than suddenly. This progressive shift of liver-glycogen rhythm was slow during the first 4 days after reversal of lighting regimen and faster thereafter. It was completed within 9 days, in intact mature male C mice. Shift-time and shift-rate change are physiologic characteristics of theoretical and applied interest. Phase shifting of rhythms by environmental means proceeds within temporal bounds set by internal phase controls. The interdependence of

superficially related periodic functions can be analyzed by phase shifting through study of their shift times.

104. HALBERG, F. 1964
Physiological rhythms.
In: J.D. Hardy, ed. Physiological Problems in Space Exploration, p. 298-322. Springfield, Ill., Charles C. Thomas, Publisher.

Discussion of physiologic rhythms. The subjects considered include scope, generality, and reproducibility of circadian rhythms, deviations from an exact 24-hr period, hormone effects in the light of circadian system analysis, resistance to injury, variance spectra, physiologic rhythms, and bioastronautics. It is stated that problems of physiologic rhythms are pertinent to human engineering for life in aerospace, particularly with respect to astronaut selection and performance. They are so, irrespective of whether this latter time dimension of life on Earth is acquired or innate, while information on the latter problem in itself is a first-order contribution to basic biology. Bioastronautics, it is said, can provide such data and thus fill a gap in present knowledge. (Reprinted from Internation Aerospace Abstracts, Inc.)

105. HALBERG, F. 1964.
Physiological rhythms and bioastronautics.
In: K.E. Schaefer, ed. Bioastronautics, p. 181-195. New York, MacMillan Co.

Discussion of biological cycles that have frequencies of approximately 24 hours. In order to answer the question of whether characteristic rhythms will be altered in extraterrestrial space, it is thought necessary that certain characteristics of rhythms in a terrestrial environment be reliably defined under specified conditions and that the conditions during study of rhythms in extraterrestrial space be defined insofar as is possible. Topics dealt with are: physiological rhythms in man; interactions among rhythms; variance spectra of physiological rhythms; circadian systems; external and internal timing of circadian systems; limits to temporal adaptation; mechanisms of circadian organization; and circadian desynchronization. A number of graphs and tables are presented and some unsolved problems are mentioned. (Reprinted from International Aerospace Abstracts, Inc.)

106. HALBERG, F. 1961.
Temporal coordination of physiologic function.
In: Biological Clocks, Cold Spring Harbor Symposia on Quantitative Biology, 25 (1960), p. 289-310. Cold Spring Harbor, Long Island, New York, The Biological Laboratory.

The circadian time structure, and adaptation of most species, is an aspect of functional integration in a given individual; its general characteristic resembles synchronization in the physical sense, i.e., frequency synchronization rather than coincidence in time of certain peaks or troughs. The generality, variability, significance, detection, and quantification of circadian rhythm are analyzed, and their synchronization with an environmental routine is discussed.

107. HALBERG, F., M. ENGELI, C. HAMBURGER and D. HILLMAN. 1965.
Spectral resolution of low-frequency small-amplitude rhythms in excreted 17-ketosteroids; probable androgen-induced circaseptan desynchronization.
Acta Endocrinol. 103:1-54.

Techniques are described to quantify objectively by use of a computer the external and internal timing, and changes thereof, of the rhythms of 17-ketosteroid (17-KS) excretion. In a subject followed for 15 years the cyclic frequencies of 17-ketosteroid excretory rhythms were found to be on the order of a week, 20 days, a month, and a year. These low-frequency small-amplitude rhythms were shown to be statistically significant upon analysis by least squares spectra. Urine volume showed a weekly crest that related to the circaseptan synchronized rhythm of excretion of 17-ketosteroids. However, fluid intake was uncontrolled and not recorded. Beginning in 1956 at age 52 the subject self-administered testosterone preparations. For nearly ten years there was a synchronization of the circaseptan rhythm of 17-KS excretion with the cyclic alteration of activity in the subject studied. Thereafter during a span of about 3 years there was a phase-drift of about-weekly rhythm of 17-KS excretion with desynchronization from a societal 7-day routine which was the subjects's cyclic professional activity pattern. (A.R.T)

108. HALBERG, F. 1965.
On: The state-of-the-art of electroencephalography and its role in manned space flight.
In: J.F. Herrick. The State-of-the-Art of Electroencephalography and its Role in Manned Space Flight, p. 16-17. (NASA TMX-57000)

This is the author's reply to a questionnaire concerning the state-of-the-art of the encephalogram for determining the competency of man during orbital space flight. In his letter he briefly outlined some of the research being performed at the University of Minnesota using computers to study the circadian and ultradian (frequencies with one cycle in 3-5 hours) frequencies of the EEG. He emphasized the need for a correlation between variance shifts in the circadian and ultradian domain of electroencephalographic frequencies with performance parameters, such as decision time, in the course of groundwork, before such plans are incorporated into bioastronautic planning.

109. HALBERG, F., M. SIFFRE, M. ENGELI, D. HILLMAN and A. REINBERG. 1965.
(Study of free-running circadian rhythms of the pulse, sleep-wakefulness cycle and time estimation in a young adult male during a stay of two months underground.) Etude en libre-cours des rythmes circadiens du pouls, de l'alternance veille-sommeil et de l'estimation du temps pendent les deux mois de sejour souterrain d'un homme adulte jeune.
Compt. Rend. Acad. Sci. (Paris) 260:1259-1262.

The circadian system of an organism is defined by the rhythms of most of its physiologic functions of which the mean period, tau, has a duration between 20 and 28 hours. For a number of organisms, the tau of a free-running circadian rhythm may be significantly different from 24 hours by some minutes or hours. In a cavern without information as to time, the circadian system may be desynchronized with respect to local time; this is an 'external circadian desynchronization.' However, the circadian system of a healthy adult man may maintain a high degree of internal circadian synchronization even in the event of an external circadian

desynchronization. In the case studied, the sleep-wakefulness cycle, the pulse rate, and the ability to estimate short periods of time were recorded. Results were analyzed by electronic computer technique. The period, tau, of the rhythms analyzed was on the order of 24.5 to 24.6 hours. The results taken together suggest that the three rhythms depend upon internal rather than external factors. The internal circadian synchronization of physiologic functions was maintained for two months despite the existence of an external circadian desynchronization. (A.R.T.)

110. HALBERG, F. 1964.
Symposium on medical aspects of stress in the military climate.
Walter Reed Army Institute of Research Symposia, p. 1-36. April 1964.

111. HALE, H.B., E.W. WILLIAMS and C.J. BUCKLEY. 1969.
Aeromedical aspects of the first nonstop transatlantic helicopter flight. III-Endocrine-metabolic effects.
Aerosp. Med. 40:718-723.

Endocrine-metabolic appraisal was made by means of urinalysis for all participants (2 crews of 5 men each) in the first nonstop, transatlantic helicopter flight. Serial urine specimens were analyzed for epinephrine, norepinephrine, 17-hydroxycorticosteroids (17-OHCS), urea, creatinine, phosphorous, magnesium, potassium, and sodium. Nonspecific stress was evident, as the flight caused a 143% gain in epinephrine, a 25% gain in urea, and a 51% reduction in the norepinephrine/epinephrine ration. It also modified the circadian trends for 17-OHCS and phosphorus. The interindividual endocrine-metabolic variablity was high. (Author)

112. HALE, H.B., E.W. WILLIAMS and C.J. BUCKLEY. 1969.
Endocrine-metabolic effects of transatlantic helicopter flight.
U.S. Govt. Res. Develop. Rep. 69(2):53.

Endocrine-metabolic appraisal was made by means of urinalysis for all participants (2 crews of 5 men each) in the first nonstop, transatlantic helicopter flight. Serial urine specimens were analyzed for epinephrine, norepinephrine, 17-hydroxycorticosteroids (17-OHCS), urea, creatinine, P, Mg, K, and Na. Nonspecific stress was evident, as flight caused a 143% gain in epinephrine, a 25% gain in urea, and a 51% reduction in the norepinephrine/epinephrine ratio. It also modified the circadian trends for 17-OHCS and P. The interindividual endocrine-metabolic variability was high. (TCVL)

113. HALE, H.B., E.W. WILLIAMS, E. TANNE and C.A. ANDERSON. 1968.
Endocrine-metabolic effects of unusually long or frequent flying missions in C-130E or C-135B aircraft.
Aerosp. Med. 39:561-570.

Flight-stress appraisal was made by means of a battery of urinary determinations (epinephrine, norepinephrine, 17-OHCS, urea, uric acid, phosphorous, magnesium, sodium, and potassium) for flyers who participated in (1) 20-hr. missions in C-130E aircraft (flights from New Zealand to Antarctica, and back), (2) 6-day missions in C-135B aircraft (earth-circling missions), and (3) 7-week missions in C-135B aircraft (overfrequent transoceanic and

transcontinental flying). The adrenal medulla (judging by urinary epinephrine) consistently showed a flight-sensitivity, but other endocrine-metabolic functions varied in ways indicative of adaptation. With flight circumstances standardized (particularly with respect to time of day), flight effects tended to be reproducible. With crew rest limited to 2 days, recovery from flight-stress tended to be incomplete. Sleep-deprivation and crew position were shown to be factors which modify flight-stress reactions. Eastbound and westbound earth-circling missions did not induce different degrees of flight-stress, as judged by these endocrine-metabolic indices.

114. HALE, H.B. 1967.
Validity of the human 17-hydroxycorticosteroid/creatinine ratio.
Aerosp. Med. 38(11):1095-1098.

The ratio of urinary 17-hydroxycorticosteroids (17-OHCS) to urinary creatinine is currently being used as a stress index in flight-stress studies. Its validity (and the validity of creatinine-based urinary ratios, generally)is often questioned, it was noted that creatinine, when used as a reference base for other urinary constituents, may be a distorting factor, as creatinine excretion is normally variable, showing diurnal variation, day-to-day variation, week-to-week and seasonal variation. Short-term and long-term time trends for urinary creatinine excretion rate, 17-hydroxycorticosteroid (17-OHCS) excretion rate, and the 17-OHCS/creatinine ratio were investigated, utilizing data obtained from 11 healthy men during forenoon and afternoon periods on 5 consecutive days in each of 4 consecutive weeks. Creatinine excretion rate did not show significant forenoon-afternoon variation, but there was forenoon-afternoon variation (P less than .01) for both 17-OHCS excretion rate and the 17-OHCS/creatinine ration, each declining as time proceeded. Using creatinine as the base for 17-OHCS did not cause distortion; instead, there was a statistical gain, as the variance was then lessened. Significant week-to-week variation was detected only in afternoon data, and it was limited to creatinine excretion rate (P less than .001) and 17-OHCS excretion rate (P less than .01), both declining progressively over the 4-week test period. Since the 17-OHCS/creatinine ratio did not show week-to-week variation, it was concluded that creatinine acted as a correction factor, eliminating the long-term variation in 17-OHCS. (From author's summary)

115. HAMAR, N. and I. SZAZADOS. 1965.
The daily rhythm of performance of female textile workers.
Acta Physiol. Acad. Sci. Hung. 26(suppl.):7-8.

The employees working regularly on daytime shifts are classified into the same stereotype system, in spite of the fact that the forenoon and afternoon shifts are alternated weekly. Within the stereotype system the dynamics of the excitatory and inhibitory processes take effect in the sense that the beginning of the forenoon shift is followed by an improvement of performance, followed by a deterioration at a point of time depending on the strain imposed by the work and the environmental influences. In the next phase spontaneous improvement then again deterioration occur, etc. The undulation of performance does not cease when the shift is over.

Employees working always on night shifts belong to another stereotype. Their rhythm of performance does not fit into the pattern shown by the daytime workers, and they display changes in body temperature. These changes in performance disposition are significant from the point of view of the system of work and rest, as well as from that of changing the shifts.

116. HARRIS, D.A., H.B. HALE, B.O. HARTMAN, and J.A. MARTINEZ. 1970. Oral temperature in relation to inflight work/rest schedules. Aerosp. Med. 41(7):723-727.

Six experimental flying missions (each of 54 hours' duration) were flown in a C-141 aircraft. Two crews took turns flying the aircraft during each mission. In three of the misssions the work/rest schedule was 4/4 hours; in the remaining missions it was 16/16 hours. Oral temperatures of 9 of the crewmembers (2 aircraft commanders, 2 co-pilots, 2 flight engineers, 2 navigators and 1 loadmaster) were measured at 4-hour intervals during the flight periods and also during 54-hour post-flight periods, with the testing schedule standardized with respect to time of day. The oral temperature rhythm during flight periods, although remaining entrained to the time at the home base, was lower in amplitude than that during post-flight periods (P less than 0.01). The 4/4 work/rest schedule had more depressant influence on oral temperature than the 16/16 schedule (P less than 0.005). Crew position was found to be a factor contributing to oral temperature variability (P less than 0.05). The individuals occupying key positions during flight periods as well as during post-flight periods.

117. HARTMAN, B.O. and C.K. CANTRELL. 1967. Sustained pilot performance requires more than skill. Aerosp. Med. 38(8): 801-803.

The impact of factors such as management, job satisfaction and workload was clearly demonstrated in research during World War II. A study of crew workload in the C-141 provided data which could be used to study living and working schedules during extended missions. A model mission was empirically derived and demonstrated major disruptions in the daily patterns of eating, sleeping and working. Situational factors associated with flying through several time zones appeared to have a primary effect. Actual reports from the field supported these findings. While it is reasonable to hypothesize that these and similar factors should reduce the aircrewman's physical and psychological fitness for sustained flying proficiency during demanding missions, the crucial studies remain to be done. (Author)

118. HAUS, E., et al. 1968. Shifts and drifts in phase of human circadian system following intercontinental flights and in isolation. Fed. Proc. 27:224.

Sleep-wakefulness, oral temperature and urinary excretion of 17-OHCS, 17-KS, K & Na were evaluated on a healthy native European man 37 years of age for 34 days in Minnesota prior to a jet flight to central Europe, 23 days in Europe before a return flight to Minnesota, 66 days in Minnesota prior to an isolation span covering 12.5 days without time cues, and an ensuing post-isolation span of 56 days. By temporal amplitude and phase diagrams, 1) external circadian desynchronization was found for each variable during isolation; 2) gradual phase shifts occurred more slowly after the flight from Minnesota to Europe, as compared to that from Europe to Minnesota.

119. HAUTY, G.T., G.R. STEINKAMP, W.R. HAWKINS and F. HALBERG. 1960.
Circadian performance rhythms in men adapting to an 8-hour day.
Fed. Proc. 19:54.

Trained individuals (5) were singly confined in a sealed 50-cubic foot chamber. Temperature and humidity varied, but not 24-hr. periodically/ level of illumination constantly high/no visual contact with outside. Constant internal noise, 85 db., effectively masked external sounds. For 7 days, subject was committed to alternate 4-hr periods of rest and work. Subjects had wristwatches set to local time but 'though mostly' in terms of 4-on/4-off. Different physiologic and psychologic functions of a given subject adjusted to a varying extent to 8-hr. day, extent of adaptations differing also among subjects. Autocorrelograms uncovered persisting circadian periodicity in heart and respiration rates and in performance. Circadian components were more significant when adaptation to 8-hr. day was more difficult. Adaptations to artificial schedules depend upon extent of modifiability of circadian physiologic periodicity shown herein to operate in subjects living for one week on a 4-on/4-off schedule. (Author)

120. HAUTY, G.T. 1961.
Circadian system analysis in aerospace medicine.
Rep. Ross Conf. Pediat. Res. 39:88-91.

After examination, indoctrination and training, subjects were confined for a seven-day period in a one-man altitude chamber. During the seven days in the chamber, the subject worked for four hours, was free for activities of his own choice and then again worked for four hours. The work consisted of several difficult tasks requiring vigilance, judgment, discrimination, and problem solving. The first subject tested appeared unable to adapt to a schedule that required an 8 hour work/rest cycle. He showed evidence of progressive fatigue and gradually decreased in proficiency. However, personnel of a highly select squadron of the Strategic Air Command, who had been accustomed for many years to irregular sleep/wake cycles and to frequent changes in activity adapted readily. Heart rate and respiration rate appeared to show periodicity of about four hours.

121. HAUTY, G.T. 1967.
Individual differences in phase shifts of the human circadian system and performance deficit.
Life Sciences and Space Research V, p. 135-147.

At periodic intervals throughout the biological day, assessments were made for a week prior to intercontinental flight yielding a reference of biological time set to the environment of origin, for two weeks at the temporally displaced environment of destination, and for a week following return to the environment of origin. Assessments made included rectal temperature, heart rate, respiratory rate, palmar evaporative water loss, urinalysis, reaction time, decision time, critical flicker fusion, subjective fatigue and well-being, and intellectual facility. The intercontinental flights consisted of east-west and west-east flights which permitted a comparative analysis of bidirectional effects of time zone displacements and a north-south flight which provided an appraisal of effects solely attributable to prolonged flight. Shifts of the phase of circadian periodicity manifested

by the physiological functions were effected by the east-west flights but not by the north-south flight. Bidirectional differences in lag time and extent of dissociation were revealed, but these may be due to individual variability. All flights engendered significant increment in subjective flights. Only one flight, the east-west, produced significant performance deficit indicating that while rapid translocation through many time zones does effect physiological phase shifts requiring 4 to 6 days for completion and impairment of well-being, these phenomena are not accompanied by a commensurate change in the efficiency of basic psychological functions. (Author)

122. HAUTY, G.T. 1964.
Human reliability and confinement.
In: M. Florian and A. Dollfus, eds. Life Sciences and Space Research. A Symposium 1963. New York, John Wiley and Sons, Inc. p. 337-351.

Problems inherent in the modifiability of circadian periodicity and in impoverished sensory environments were explored for the purpose of appraising attenuative effects upon human reliability. Accordingly, highly selected subjects were confined within a one-man altitude chamber for prolonged periods of time and under a variety of designed conditions. The findings relative to the modifiability of biological rhythm indicate that adjustment to a drastic revision of the 24-hour biological day was accompanied to a significant and practical extent by certain subjects, the extent of adjustment was directly related to the maintenance of high initial levels of proficiency, and just as subjects differ greatly in their adjustment to revised biological time, they differ to an equal extent in the degree of synchronization manifested by the apparent periodicities of the different physiological systems. In the investigation of impoverished sensory environments, it was found that the joint effects of impoverished sensory conditions and continuous work at an operator system drastically degraded the reliability of certain subjects. Further, neither prior experience nor knowledge acted to mitigate the degree of aberrancy experienced which in the case of one subject was so extreme as to necessitate his removal from the chamber prior to the termination of confinement period. Finally, management of certain aberrant behavior, specifically hallucinatory experiences, could be successfully achieved by those subjects who continuously attempted to maintain a diversity of sensory input. (Author)

123. HAUTY, G.T. 1962
Periodic desynchronization in humans under outer space conditions.
Ann. N.Y. Acad. Sci. 98(4):1116-1125.

Volunteers were each confined in a one-man space cabin simulator for 7 days, each of which was divided into 3 periods of 8 hours, with 5 hours work and 3 hours sleep or rest. Task proficiency was continuously recorded for each of the two participants in this experiment and hourly recordings were made of pulse and respiratory rates as well as environmental factors. In one subject the circadian component of the heart rate periodogram peaked at about 25 hours and showed less significant periods of about 4 and 6 hours. The respiratory rate peaked at nearly 24 hours and did not show periods of about 4 and 6 hours. In the second subject the heart periodogram showed three equally pronounced components peaking at 4,8, and 24 hours. The same periods were seen in the respiratory rate periodogram but

the circadian component was less pronounced than the 4 and 8 hour peaks. The task proficiency of the first subject declined progressively and on the 7th (24-hour) day deteriorated markedly. The task proficiency of the second subject exhibited no progressive decline and, in fact, was higher during the last four (24-hour) days than in the first three. It was concluded that the second subject adjusted significantly to the imposed 8-hour day regimen while the first subject, who failed to adapt well, became progressively fatigued as evidenced by deterioration in the execution of those tasks requiring high levels of vigilance and judgement. (A.R.T.)

124. HAUTY, G.T. and T. ADAMS. 1965.
Phase shifting of the human circadian system.
In: J. Aschoff, ed. Circadian Clocks. Amsterdam, North-Holland Publishing Co., p. 413-425.

Effects on the circadian rhythm of rectal temperature, reaction time, decision time, critical flicker-fusion, and subjective fatigue were reported for a transmeridian flight from Oklahoma City to Tokyo and the return flight eleven days later. Three to five days were required for the primary shifting of phase and one day for the shift in phase back to its original relationships. Behavioral integrity was degraded during the transitional period in Tokyo and, to a lesser extent, during the period of transition back to the environment of origin. Differences in subject responses due to age, 6 males from 19 to 23 years and 3 males from 40 to 48 years, were also discussed.

125. HAUTY, G.T. and T. ADAMS. 1966.
Phase shifts of the human circadian system and performance deficit during the periods of transition. I. East-west flight. Aerosp. Med. 37:668-674.

At periodic intervals throughout the biological day biomedical assessments were made for a week prior to jet flight to Manila, for 8 days of layover at Manila and for a week following return to the environment of origin. The data revealed that for the physiological functions, assessed, time displacement effected a primary shift of phase of circadian periodicity which, for rectal temperature and heart rate, required 4 days for completion and, for palmar evaporative water loss, approximately 8 days. Return back to the environment of origin also effected a shift of phase requiring only 1 day for completion. Behavioral integrity was degraded during the primary period of transition and, to a lesser extent, during the period of transition occasioned by return to the environment of origin but duration of behavioral impairment was much shorter than the lag time of physiological phase shifts. (Author)

126. HAUTY, G.T. and T. ADAMS. 1966.
Phase shifts of the human circadian system and performance deficit during the periods of transition. II. West-east flight.
Aerosp. Med. 37:1027-1033.

At periodic intervals throughout the day, biomedical assessments were made during the week prior to jet flight to Rome, hroughout a 12-day layover period in Rome, and during the week following return to Oklahoma City.

Completion of the primary shift of phase of the circadian periodicity manifested by internal temperature and heart rate required from 4 to 6 days and 6 to 8 days, respectively. Increase in subjective fatigue occurred during the primary period of transition and following return to the environment of origin, but psychological performance was not impaired to any statistically significantly extent during either of these periods. Compared to the time lag of the physiological phase shift, the duration of subjective fatigue was very short. Comparison of these results with those obtained from a previous East-West flight did not reveal striking bidirectional differences save for the possible exception of psychological performance which was significantly impaired in the case of the East-West flight. (Author)

127. HAUTY, G.T. and T. ADAMS. 1966.
Phase shifts of the human circadian system and performance deficit during the periods of transition. III. North-South flight.
Aerosp. Med. 37:1257-1262.

At periodic intervals throughout the biological day, biomedical assessments were made for a week prior to jet flight to Santiago, for 12 days in Santiago, and for a week following return to Washington, D.C. From a comparison of these data with those obtained from the east-west and west-east flights, the following conclusions were drawn: while the east-west and west-east flights effected a primary shift of phase of circadian periodicity manifested by the physiological functions, the north-south flight did not. This latter flight, however, did produce a significant increment of subjective fatigue as did the other two flights but was not followed by a significant performance deficit. (Author)

128. HAUTY, G.T. 1963.
Relationships between operator proficiency and effected changes in biological circadian periodicity.
Aerosp. Med. 34:100-105.

Subjects confined in a one-man cabin simulator equipped and instrumented with life support systems and provisions capable of sustaining a subject for several days. The subject's mobility was severely limited and an attempt was made to eliminate certain physical and psychological cues to which man is normally accustomed. There was no voice contact and an internal noise level of 84 decibels, produced by air flow blowers, masked any noise which might have been transmitted into the chamber. Vision was confined to the interior of the chamber. A constant level of illumination was maintained and each subject used an eye shield for sleeping periods. Work consisted of several different tasks requiring the functions of spatial discrimination, perceptual judgment, vigilance, and problem solving. Each of the seven 24-hour days the subjects were in the simulator was apportioned into three 8-hour days of which the first four hours were spent performing the tasks provided by the operator system. From the data obtained it appeared that if attenuation of the circadian component and corresponding development of more appropriate periodic components can be taken to signify adaptation to revised biological time, the subjects demonstrated an appreciable degree of adaptation to the 8-hour sleep-wakefulness cycle imposed upon them. (A.R.T.)

129. HAZEN, I.M. 1970.
The problem of homeostasis in space medicine.
Develop. Sci. Heritage of K.E. Tsiolkovskiy, p. 91-98.

Discussed are life support systems and space suits able to preserve the homeostatic reactions of astronauts. Effects of habitation environment, acceleration, and weightlessness determine the design of life support systems. Emphasis is placed on the mechanisms of the effect of acceleration on physiological systems and the maintenance and preservation of the relative constancy of bodily functions. Highly suggested is a reclining position for man during launching in a rocket in conjunction with preliminary physical training and preparation. (G.G.) Reprinted from STAR, 1970.

130. HILDEBRANDT, G. 1966.
Die bedeutung der umweltriege fur den tagesrhythmus des menschen.
Z. Angew. Bader - u. Klimaheilk. 13:626-644.

131. HILDEBRANDT, G., P. ENGEL and E.D. VOIGT. 1968.
(Rhythmological problems of aerospace medicine.) Rhythmologische probleme der raumfahrtmedizin.
In: H. Buecker, ed. Extraterrest., Biophys., Biol. and Space Med. p. 285-303. Frankfurt, Johann-Wolfgang Goethe-Universitat.

Test results and diagnostic findings are reviewed of numerous works related to the rhythmological aspects of space flight. Among the subjects covered are isolation experiments, desynchronization, disturbances of frequence and phase coordination, the circadian rhythm, and sleep-wake cycles; also discussed are factors affecting the metabolic and excretory functions, adaptation, and the capacity for physical work. (Transl. by K.W.) Reprinted from STAR.

132. HOFFLER, G.W. 1967.
Circadian and other rhythms in biophysiology.
J. Med. Assn. Georgia 56:329-332.

The existence and interaction of endogenous free-running and exogenous circadian rhythms entrained by zeitgebers are discussed. Other physiologic rhythms such as heart beat and mitotic cycles are mentioned. Diurnalism and nocturnalism in various species, such as arthropods, larger animals, birds, aquatic forms of life, and higher vertebrates, are touched upon. Many types of research studies are mentioned. Biological rhythms in man are listed, including those of temperature, urine excretion, excretion of water, creatinine, uric acid, urea, amino acids, electrolytes, and 17-hydroxycorticosteroids. Underground studies of sleep-wakefulness, body temperature, urine volume, electrolyte excretion, and other cyclic variations are mentioned, and desynchronization of rhythms is discussed. The "master clock" concept and its limitations point to the conclusion that much additional scientific work needs to be done. (A.R.T)

133. HOLMQUEST, D.L., K. RETIENE and H.S. LIPSCOMB. 1966.
Circadian rhythms in rats - effects of random lighting.
Science 152:662-664.

Increase in body weight, spontaneous running activity, and adrenal cortical

function have been studied in rats exposed to a random lighting schedule. In two separate experiments, grouped control animals were given 12 or 14 hr of light alternating with 12 or 10 hr of darkness, respectively, while corresponding grouped experimental animals were given the same total amounts of light and darkness per 24-hr period in a randomized pattern. Random light for periods of 17 to 40 days exerted no influence on growth rate, on weights of endocrine organs, or on adrenal response to adrenocorticotrophic hormone. However, the physiological fluctuation of group running activity and adrenal steroid secretion was abolished. Group desynchronization and the development of circadian rhythms having periods both shorter and longer than 24 hr appear to have replaced the synchronized group rhythmicity. (Author)

134. JACKLIN, S.W. and C.E. YONCE. 1969.
Induced shift of the diurnal emergence and calling of the peach tree borer (Sanninoidea exitosa).
J. Econ. Entomol. 62(1):21-22.

Sanninoidea exitosa (Say) moths were induced to emerge in synchronization with light cycles occurring both earlier and later than the solar day. Also, the time of the 1st call by female moths was similarly shifted. Moreover, moth calls on the subsequent days of adult life were rescheduled to synchronize with a different light cycle than the one that prevailed when they emerged and made their 1st call. (Author)

135. JAULMES, C.H., A.C. BENITTE et al. 1961.
Voyages aeriens lointains. Troubles du rhythme nycthemeral et depaysement climatique. Deuxieme journee de physiologic appliquee du travail humain problemes physiologiques poses par les transports.
Revue de Metrologie p. 107-122.

136. JENNER, F.A., J.C. GOODWIN, M. SHERIDAN, I.J. TAUBER, and M.C. LOBBAN. 1968.
The effect of an altered time regime on biological rhythms in a 48-hour periodic psychosis.
Brit. J. Psychiat. 114:215-224.

A patient who had developed a periodic rhythm of being depressed and lethargic for 24 hours then elated for 24 hours (accurate to about an hour) continuously throughout 11 years was placed with a normal control subject in an artificial environment in which the period of light and darkness, unknown to the subject of the study, totaled 22 hours instead of 24. During the 11 days of the experiment it was possible to show that a 48-hour manic-depressive psychosis could be changed to a 44-hour rhythm. Measurements were made of the renal excretion of water, sodium, potassium, chloride, magnesium, calcium, phosphate, creatinine, 17-ketogenic steroids, and 17-ketosteroids, as well as urine pH, body temperature and pulse rate. Computer analysis of the data is described and the significance of the data is discussed. (A.R.T.)

137. JONGBLOED, J. 1963.
(Medical problems concerning space flight. IX. The training and selection of the astronaut.) Medische yraagstukken in verband met de ruimtevaart.

IX. De oplieding en de selectie van de ruimtevaarder.
Ned. Tijdschr. Geneesk. 107:1278-1280.

The selection and training of astronauts evolved by the Russians and Americans are reviewed with respect to the basic requirements, general academic instruction, space flight physiology, exposure to simulated space stresses including isolation, and training in space flight maneuvers. Special preparations taken before orbiting the astronaut are described. Monitoring of the vital physiological parameters of the astronaut from earth is underlined. With the advent of longer space flights, the age of future astronauts will become of great importance, possibly introducing the field of 'astrogerontology.' Adaptation to long term weightlessness and disturbed diurnal periodicity may result in new problems upon return to earth's gravity. Special arrangements may be needed for modification of the sleep-wakefulness cycle under space flight conditions because of the lesser fatigue and need for sleep. Certain other work-rest cycles are suggested as more feasible in space flight.

138. JUIN, G. and P. PINEAU. 1962.
(Basis, protocol and results of an investigation of fatigue of the air crews flying aboard commercial Boeing 707s.) Bases-protocole et resultats d'une enquete sur la fatigue des equipages volant a bord des Boeing 707 commerciaux.
L'Ouest-Medical 15(3):100-105.

Clinical, biological, and physiological tests were made on 136 members of flying crews before, during, and after transatlantic or transpolar flights aboard Boeing 707 jets, then aboard DC-6 and DC-7 piston-engine planes to measure, if possible, the physical and psychological impairment occurring with the two types of planes travelling comparable distances. The subjects studied are categorized as to age, sex and occupation. The battery of tests used is described but the detailed analysis and statistical treatment of the data are presented elsewhere. The clinical results obtained in the study of changes in blood pressure are discussed and shown in tabular form. In terms of mean variations of maximal and minimal blood pressure levels among jet aircrews, there was found a compression of the differential which, on the homeward journey, particularly, affects 90 percent of cases among both technical and other flying personnel, the compression being brought about essentially by lowering of the maxima and raising of the minima. On conventional (piston-engine) aircraft, even after a long flight interrupted by many stops, the blood pressure undergoes practically no modifications. When separated by a rest period, practically identical figures for blood pressure were obtained for outward and return flights, as is there was a disappearance of the factors conditioning the low pressure and the differential compression. (A.R.T.)

139. JUIN, G. 1961.
(An investigation of fatigue aboard jet airplanes.) Une enquete sur la fatigue a bord des "jets."
Presse Med. 69(24):1104-1105.

The principal conclusions include the following: 1st, it is affirmed unequivocally that a greater degree of medically established and measured

fatigue exists in flying personnel aboard jets than in such personnel doing essentially identical work aboard conventional aircraft; 2nd, the disturbances observed include the reaction of physiologic response to a state of exhaustion in both the endocrine and metabolic domains; 3rd, these disturbances manifest themselves equally in the domain of oculomotor equilibrium and that of neuromuscular excitability; 4th, it was apparent that recuperation from this fatigue was slower and less complete, even though the rest periods were practically identical, by comparison with that which takes place after flights in conventional aircraft. It was further found that the cumulative effects of fatigue from jet flights last much longer and are less well corrected than equal fatigue accumulated on conventional aircraft. The reactions of exhaustion are more marked in pilots and flight commanders, who have greater responsibilities, than in other members of the flight crews. (A.R.T.)

140. JUIN, G. 1963.
[Time zone changes (their features and their consequences in commercial aviation).] Les decalages horaires (leurs aspects et leurs consequences dans l'aviation commerciale).
Arch. Mal. Prof. 24:113-117.

Several reports are quoted concerning the existence of circadian rhythms of physiological functions that can become important factors in maintaining human efficiency among flying personnel who may cross 140 meridians (France to Japan) in a single supersonic flight. The disruption of the sleep-wakefulness cycle is the most important single consideration; others include circadian rhythms of nervous and psychologic equilibrium, temperature, respiratory and cardiovascular rhythms, digestion (eating habits, feelings of hunger), gastric and intestinal contractions), endocrine and other biochemical functions. (A.R.T.)

141. KLEIN, K.E., H.M. WEGMANN and H. BRUENER. 1968.
Circadian rhythm in indices of human performance, physical fitness and stress resistance.
Aerosp. Med. 39(5):512-515.

In order to estimate the existence and magnitude of rhythmic day-night variations in human performance, physical fitness and stress resistance, the following variables were measured every three hours over a full day-night cycle: The reaction time and its individual constancy, the maximal psychomotor coordination ability, the Schneider index, the predicted VO2 max, the cardiovascular responses to tilting, the 'time of useful consciousness' at simulated altitude. The twenty-four hours were divided into two experimental sessions so that limited sedentary activity could be maintained between the tests. All parameters (including body temperature, blood eosinophils, plasma-protein, aldolase and 17-OHCS) revealed relative rhythmic oscillations of the circadian type, the ranges of which varied for the group average between 1.4 percent (temperature) and 68 percent (17-OHCS) from the total twenty-four hour average. Negative extreme values were shown during the night hours for all cardiovascular parameters; consequently, the Schnieder index and the VO2 max predicted from the heart rate level during submaximal exercise had their positive peaks or best values at this time of the day. (Author)

142. KLEIN, D.E., H. BRUENER, H. HOLTMANN, H. REHME, J. STOLZE, W.D. STEINHOFF and H.M. WEGMANN. 1970.
Circadian rhythm of pilot's efficiency and effects of multiple time zone travel.
Aerosp. Med. 41:125-132.

If a standard instrument flight in a supersonic simulator was repeated in intervals of 2 hours the average performance of 12 pilots revealed a sinusoid circadian rhythm curve with the temporal position of peak and trough between 2-3 p.m. and 4-5 a.m., respectively. The amplitude of the diurnal oscillation came to an average of plus or minus 25 (12-49)% of the 24-hours total average as against plus or minus 12% found on average in the same subjects for the simple reaction time. After rapid transportation from Europe to the U.S. and back with a sojourn of 17 days (time shift: 3 h), the duration of resynchronization was about 5 days on average for both directions with a rate of phase adjustment of approximately 1.5 (1-2)h/day. The change in the performance level following transit, in dependence of the coincidence of old and new clock time, was unequal during the course of the day, but in general the level was significantly decreased (up to 40%) at daytime and increased during the late night hours. A performance decrement seen for the 24-hours total average, in comparison to the preflight control, was significant only after the eastward (8.5%) but not after the westward (3.3%) flight. The reason for this difference is mainly seen in a greater fatigue due to an unfavorable flight schedule and the more severe sleep loss connected with eastward traveling. (Author)

143. KLEIN, K.E., H.M. WEGMANN and B.I. HUNT. 1972.
Desynchronization of body temperature and performance circadian rhythm as a result of outgoing and homegoing transmeridian flights.
Aerospace Med. 43(2):119-132.

Rectal temperature and performance were studied and urine samples taken in a group of eight Unites States residents before and after flights between the U.S.A. and Germany. Measurements were performed nine times per day "round the clock" at three-hour intervals on three days before the outgoing flight and on days 1,3,5,8, and 13 following the flights in each direction; temperature measurements and urine collections were also made on the postflight days 2,4 and 6. The difference in local time was six hours; the duration of stay in Germany was 18 days. Using the multiple regression technique, mode and duration of resynchronization were evaluated for phase, amplitude and 24-hour mean. After fitting a quadratic equation to the derived set of phase angles it was found that it took 14-15 days following the east-bound and 11-12 days after the west-bound flight for the phase of the temperature rhythm to readjust completely. For the more complex (psychomotor) performance task the corresponding figures were 12 and 10 days; for the simpler ones, including visual reaction time, they were nine and six days, respectively. Minor depressions of the 24-hour mean on the first day after travel - for temperature about 0.1°C, for performance betwen 2.1-3.2% (east-bound) and 1.1-2.4% (west-bound) - proved not to be statistically significant. Phase shift, amplitude reduction and decrease of the 24-hour mean together resulted in a depression of temperature significant on both 1st postflight days. This depression occurred mainly at 1200 and 1500 hours after east-bound travel and at 2100 and 2400 hours after west-bound travel. At the same time postflight temperature was significantly elevated for five days between 2400 and 0600 hours after east-bound travel

and for three days between 0600 and 0900 hours after west-bound travel. Performance revealed depressions and elevations of 6-10% at similar clock hours of the day; these were significant in some instances. The more pronounced and longer lasting effect of east-bound travel is in concordance with the earlier results obtained from studies done with German residents. It is concluded that the relative flight direction, i.e., in relation to the traveller's permanent home is no major factor affecting de- and resynchronization of human circadian rhythm.

144. KLEIN, K.E., H. BRUENER and S. RUFF. 1966.
(Investigations on stress imposed on aircrew in civil jet aircraft during long-range flight: Report on results on the northern Atlantic route.) Unterauchungen zur belastung des bordpersonals auf fernflugen mit dusenmaschinen bericht uber die ergebnisse auf der nordatlantik-route.
Z. Flugewissenschaften 14:109-121.

The following data were determined on crew memebers of German trans-atlantic airliners, over a period of twenty-five scheduled flights: pulse and blood pressure, electrocardiogram, oral temperature, eosino-ohil count, hematocrit, hand coordination, psychomotor performance, and optical reaction time. In addition, each test subject answered a question-naire regarding personal discomfort (headaches, etc), thirstiness, fatigue, etc. Results were tabulated and are graphically represented. (Cir. Rhy. Bibl. by Heller).

145. KLEITMAN, N. 1961.
Physiological cycling.
In: B.E. Flaherty, ed. Psychophysiological aspects of space flight, p. 158-165. New York, Columbia University Press.

This review of studies correlating body temperature rhythm with fluctuations in alertness and performance concludes with recommendations concerning the establishment of fixed work-sleep cycles for space travelers: (1) further trail of 'close' watch schedules; and (2) experimentation with longer-than-24-hour cycles of activity and rest. (J.)

146. KOJIMA, A. and Y. NIIYAMA. 1965.
Diurnal variations of 17-ketogenic steroid and catecholamine excretion in adolescent and middle-aged shift workers with special reference to adaptability to night work.
Ind. Health 3(1/2):9-19.

Diurnal variations of 17-ketogenic steroid, catecholamine, sodium, potassium, calcium and inorganic phosphate excretion in 3-shift workers were investigated to obtain information on the adaptability to night work, with special regard to age-difference. Catecholamine excretion rhythms, particularly adrenaline (epinephrine) rhythm, which generally show the peak in daytime in ordinary non-shift work, were demonstrated to be adapted rapidly to night work, though not to a large extent, by the finding that the peak of excretory rhythm corresponded to the physical and mental activities in the night shift. The diurnal rhythm of 17-ketogenic steroids appeared to be

flattened only on the 5th day of the night work in the middle-aged workers and the 2nd highest peak of the rhythm was observed in the evening of the night shift day in the adolescents. Potassium rhythm was dissociated from the other electrolyte ones which were maintained in the normal rhythms even in the night shift. The age-difference of adaptability to night work is discussed from the diurnal rhythms of 17-ketogenic steroid and epinephrine excretion. (Authors)

147. KOSILOV, S.A. and B.A. DUSHKOV. 1967.
(Physiological basis of human adaptation to specific work conditions.)
Fiziologicheskoe obosnovanie priposobleniia cheloveka k spetsificheskim usloviiam deiate'nosti.
In: N.N. Gurovskii, ed. Ocherki Psikhofiziologii Truda Kosmonavtov, p. 14-32. Moscow, Izdatel'stvo Meditsina.

Discussion of fatigue encountered by cosmonauts and the urgent need for a scientifically based fatigue-prevention program. An effective method of preventing fatigue is a rational work and rest schedule. Physical and mental fatigue, adaptation to altered circadian rhythms, and mechanisms of such adaptation are treated in detail. The complicating effects of weightlessness and emotional tension on fatigue and biorhythms are considered, and the use of hypnosis, electrosleep, and drugs is suggested as a means of facilitating adaptation to the working conditions prevailing during prolonged space flights. (I.P.)

148. KOSMOLINSKAYA, F.P. 1967.
Biological rhythms and development of work and rest regimes for cosmonauts.
Space Biol. and Med. 1(5):136-141.

The problem of periodic (daily, seasonal, annual) changes of the physiological functions of man, animals and plants long has attracted the attention of scientists of different specializations, and especially physiologists, physicians and biologists. Periodic changes of light and darkness, temperature and humidity, barometric pressure, electromagnetic and radiation phenomena in the atmosphere and many other external factors determine the rhythmic character of biological rhythms. Obviously, at the present time it is the daily variations of human physiological functions which are of the greatest importance for cosmonautics. In developing the optimum and specific work and rest regimes for cosmonauts it is impossible to overlook the fact that the physiological activity of man, his work capacity and "operational vigilance," all other conditions being equal, are dependent on the time of the solar (astronomical) day. Numerous experimental investigations have demonstrated that the daily rhythm of man is characterized by a gradual increase of the level of physiological reactions of the body in the daytime hours and its decrease at nightime. The highest level of physiological activity is observed at approximately 1200-1800 hours, and the lowest at 0200-0500 hours.

149. KOSMOLINSKIV, F.P. 1968.
Some problems in aviation physiology.
Aerosp. Med. 28:115-120.

An overview is presented on the practical objectives which should be considered in aviation physiology research. These are identified as (1) the adaptation and compensatory physiological-biochemical mechanisms; (2) the development of scientifically sound methods of preventing the injurious effects of external stimuli, and of improving the tolerance of these effects if they cannot be avoided; (3) external factors which reduce productivity and lower human efficiency; (4) the efficiency and fatigue processes in flying personnel; (5) properly planned flight training; and (6) increasing physiological reserves through physical conditioning, and proper work, rest and eating schedules. The Soviet approach to fatigue studies is defined as one which used an integral evaluation of the changes in several functions. Because of the intense cardiovascular reactions that occur in pilots, stress is placed on the necessity of devising methods of increasing endurance and efficiency while decreasing nervous and emotional strain. (M.G.J.)

150. KOSMOLINSKY, F. and B. DUSKOV. 1968.
Specific features of adaptation of a human organism to prolonged stay in sealed chambers.
Aerosp. Med. 39:508-511.

Experimental study of the functional condition of the human organism during prolonged containment in small-volume sealed chambers with some simulation of space-flight factors. Containment in a sealed chamber under conditions of relative social isolation and sensory deprivation is shown to affect the nervous, emotional, and physical performance of the subjects tested. The experiments demonstrated a correlation of many physiological indices, thus indicating a necessity for using complex techniques to evaluate the condition of the subjects during the experiment. It is shown that hypodynamia is one of the chief environmental factors affecting the organism and that close attention should be devoted to the physiology of activity. The variation in psychophysiological functions with changing circadian work-rest regimens indicates the importance of taking into account the problems associated with biorhythmology. (T.M.) Reprinted from International Aerospace Abstracts, Inc.

151. KRATOCHVIL, C.H. 1967.
Circadian rhythm and military men.
Aerosp. Med. 10 p.

Reviewed are aspects of the problems of circadian rhythm and military man in which an attempt is made to answer questions concerning performance decrement related to the reversal of day-night cycles of combat troops traveling through multiple time zones via high speed transport aircraft. Questions considered are: What kind of performance will be expected while the adjustment to the new time schedule is proceeding? (2) Will there be any increase or decrease in susceptibility to various stressors? (3) How long does it take to adjust? (4) Can anything be done to speed up this process? Discussed are investigations directed toward problems of fatigue, sleep deprivation, and change of work shifts. Studies are cited which indicate that: (1) there is a change in both efficiency and susceptibility to stress as a function of time of day; (2) during adjustment to new time zones, circadian temperature rhythm may quickly adjust to new time; however, renal

excretion patterns may lag behind; (3) there is a direct interrelationship between EEG activity, dreams, and variations in plasma steroids; and (4) our understanding of therapeutic drugs does not afford us the tools for inducing normal, physiological sleep. Given the existence of these phenomena and the very real possibility that these factors are of marked operational importance, the following solutions are proposed: (1) either travel to the new time zone well in advance of having to perform at peak efficiency; or (2) preadapt to the home station. (S.C.W.)

152. KRAUSE-LIEBSCHER, I. 1968.
(Problems of efficiency of the visual system in shift and night-work.) Zagadnienia sprawnosci narzadu wzroku przy pracy na zmiany; pracy nocnej.
Klin. Oczna 38(1):61-66.

The influence of biological rhythm on the visual function, particularly in connection with age, was established by the author's investigations. The necessity of having minute work performed during morning hours is stressed. The insufficiency of accommodation, particularly in persons working exclusively at night, has been noted. Disturbances of this kind were not observed in workers in multi-shift plants. (Modified author summary)

153. LAFONTAINE, E., J. LAVERNHE, J. COURILLON, M. MEDVEDEFF and J. GHATA. 1967.
Influence of air travel east-west and vice-versa on circadian rhythms of urinary elimination of potassium and 17-hydroxycorticosteroids.
Aerosp. Med. 38:944-947.

The influence of air travel east-west and vice-versa on circadian rhythms of urinary potassium and 17-hydroxycorticosteroids was measured on flights from Paris to Anchorage and Anchorage to Paris. The urinary potassium and 17-hydroxycorticosteroids which, taking the average of the subjects involved, show the lowest standard deviation and the clearest circadian variation, seem particularly interesting for studying the biological effects of time-zone changes. After a quick round-trip with a 20-hr exposure to a negative time-zone change of 11 hr, the circadian eliminatory rhythm of potassium and 17-hydroxycorticosteroids immediately becomes concordant with the pre-existing reference rhythm again. During a journey with a 5-day exposure to a negative time-zone change of 11 hr, the circadian eliminatory rhythm of these same elements begins to adapt itself to local time on the third day; this adaptation is complete on the fifth day, the excretive rhythms then being in opposition to the preestablished reference rhythms. (Author) Reprinted from International Aerospace Abstracts, Inc.

154. LAFONTAINE, E., J. SIROT, J. PASQUET and J. LAVERNHE. 1967.
(Influence of east-west and return trips on the circadian rhythms of diuresis and urinary elimination of sodium and potassium.) Influence des voyages agriens est-ouest et vice versa sur les rythmes circadiens de la diurese et de l'elimination urinaire du sodium et du potassium.
Rev. Med. Aeron. et Spatiale 6(23):11-15.

Diuresis and urinary elimination of sodium and potassium were measured for

a group of 10 subjects by collecting 24-hour urine samples in six 4-hour segments, which allowed us to establish circadian oscillations of the eliminations (2/24 hour percentage in each specimen). Eight and two subjects were used in varying stopover and flight periods in Paris and Anchorage. (Author)

155. LAFONTAINE, E., H. GHATA, J. LAVERNHE, J. COURILLON, G. BELLANGER and R. LAPLANE. 1967.
Rythmes biologiques et decalages horaires.
Concours Med. 89:3731-3746.

156. LAUSCHNER, E.A. 1968.
(Medical aspects of future mass air transport.) Medizinische aspekte des massenflugverkehrs von morgen.
Ther. Ber. 40(165):165-171.

Summary of the findings of the FAUSST committee (French-Anglo-U.S. Supersonic Transport), relating to problems associated with mass transport by supersonic aircraft. The areas investigated include effects on both the aircraft and passengers, and cover such categories as radiation, ozone toxicity, sudden pressure drops, temperature, humidity and internal cabin pressure, time-zone physiology, air sickness, and crew fitness. The physiological and psychological effects of sonic boom on the general population are discussed, and it is hoped that both engineers and airlines will pool their available knowledge to dampen sonic boom to levels which are tolerable and acceptable to the general public. (B.H.)

157. LAVERNHE, J., E. LAFONTAINE and R. LAPLANE. 1965.
[The subjective effects of time-zone changes. (An investigation among Air France flying personnel.)] Les effets subjectifs des decalages horaires. (Une enquete aupres de personnel navigant d'Air France.)
Rev. Med. Aeronautique 4(15):30-36.

The rapid crossing of time zones leads to retiring at the usual time for getting up or taking the midday meal during the night. The internal physiological clock is no longer on sun time. Many biological activities operating on a day-night cycle are turned topsy-turvy. Adaptation to the new time rhythm leads to fatigue and temporal disorientation. This may not be too important for the passengers. For the crews, however, the repetition of time variations plays an important part in occupational fatigue. In this study, an attempt has been made to assess the importance of the problem on the basis of subjective data gathered in interrogating the subjects on two specific points: sleep and digestive functioning. A questionnaire was given 847 subjects of whom 312 (37 percent) replied; 70 percent of the navigators and 53 percent of the captains, however, replied to the questionnaire. Each reply was catalogued as to sex, occupation, and age of the subject. Results are shown in tables. The importance of the problem of physiopathologic difficulties resulting from crossing time zones is attested by the fact that 78 percent of crew members suffered more or less, principally from disturbed sleep, or with their digestive functions, or both. It is considered that contributing to these troubles are nervous tension, climatic changes, and eating at unusual times. Airplane crew

members adjusted to the new time rhythm in about 48 hours in 70 percent of cases but 30 percent required 72 hours. The more youthful subjects suffered less than the older personnel who had more responsibility. A.R.T.)

158. LAVERNHE, J. 1964.
(Life cycle and rapid changing of zone times during aerial travel.)
Rythme de vie et changements rapides de fuseaux horaires au cours des voyages aeriens.
Presse Med. 72(44):2623-2626.

Time displacement during air travel causes an interruption of the nycterohemeral cycle, which in turn causes biological ill-effects. Commercial flying crews experience mainly fatigue and digestive disorders. The best ways for overcoming these two ill-effects are discussed. (Author)

159. LAVERNHE, J. 1970.
Physiopathological effects of changes in the time table on flying personnel in civil aviation.
Muenchen Med. Wochenschr. 112(39):1746-1752.

Physio-pathological effects of changes in the time table on flying personnel in civil aviation. The comments from civil aviation crews subjected to time table changes show that at least ½ of them suffered disturbances in sleeping and that they seem to require two or three nights to return to a normal sleeping-waking rhythm. It is possible to objectify these adaptation phenomena by the study of the daily variations in the urinary excretion of potassium and the 17-hydroxy-steroids, heart rate and respiratory rate, rectal temperature and evaporation from the skin, for example. Investigations on the volunteers subjected to time table changes show that the objective delays in adaptation are general greater than delays estimated by those involved; these delays may be 8 days, or even longer.

160. LAVERNHE, J., G. BELLANGER and J. VAN PETEGHEM. 1968.
(Subjective and objective reactions to disruptions of circadian rhythms following long-distance flights east-west and vice-versa.) Reactions subjectives et objectives aux ruptures des rythmes circadiens los des vols long-courriers est-ouest et 'vice-versa.'
Presse Med. 76:347-348.

Travelers on long-distance flights often find that their sleep is disturbed and that it takes two or three nights to recover a normal sleep/wakefulness rhythm. The phenomena of adaptation can be studied objectively by measurement of urinary elimination of potassium and 17-hydroxycorticosteroids, pulse and respiratory rates, and rectal temperature. After flights of 7 hours it takes 4 or 5 days for the organism to adapt itself to the new time zone. Flying personnel consider that it is more difficult to adjust to new time-zone rhythms after a long-distance west-east flight. This view is borne out by objective data. (A.R.T.)

161. LAVERNHE, J., E. LAFONTAINE and J. PASQUET. 1968.
(Subjective and objective reactions to breaks in the circadian rhythm during east-west, and vice versa, long-distance commercial flights.)
Les reactions subjectives et objectives aux ruptures des rythmes

circadiens lors des nols commerciaux longs-courriers est-quest et vice-versa.
Rev. Med. Aeron. et Spatiale 7:121-123.

Review of recent literature on the effects of transatlantic flight on the circadian rhythm. Changes in the regular schedule during transatlantic flight in excess of 7 hr are shown to cause readjustment periods of from 4 to 5 days. In 41% of the cases, accompanying digestive troubles - e.g., constipation - were also reported. (M.G.) Reprinted from International Aerospace Abstracts Inc.

162. LEBEDEY, V. 1968.
Scientist reviews problems of space psychology.
In: Problems of Space Res. Invest.,p. 1-12. New York, Joint Publications Research Service.

Psychophysiological factors affecting interplanetary spacecrews are reviewed. The electromagnetic field influence on mental processes is examined, and it is hypothesized that a system of bioelectric potentials, located on body surfaces, interacts with the earth's magnetic field. A general physiological mechanism of a conditioned time reflex (biological clock) is considered in terms of the effect of the pulsating geomagnetic field. An understanding of these phenomena is necessary to explain the effects of the absence or variations of terrestrial magnetism on the processes of cosmonauts. An evaluation of the periodical rhythm of plant and animal life activities and its interruption led to the conclusion that a sound rhythm activity must be established for crew members to maintain high operational capabilities and to raise the reliability of the man-automaton system. (B.P.)

163. LEONOV, A.A. and V.I. LEBEDEV. 1968.
Cosmic flight watch-standing and psycho-physiological rhythms.
Perception of Space and Time in Outer Space, p. 8-15.

The effects that interruptions in the usual circadian rhythm will have on the psycho-physiological functions of cosmonauts are considered in terms of creating new and optimum rhythms for activities on an interplanetary spacecraft. Experimental data are reviewed to show that although the physiological processes of man under constant conditions continue to maintain the circadian rhythm for a period of time, orientation without the availability of time pieces is unreal. Although there is no definitive answer as to how long a cosmonaut will be able to carry out watch-standing duties before succumbing to fatigue, the consensus is that the most optimum period should be less than four hours. (M.G.J.) Reprinted from STAR.

164. LEWIS, H.E. 1961.
Sleep patterns on polar expeditions.
In: G.E. Wolstenholme and M.J. O'Connor, eds. The Nature of Sleep. Boston, Little, Brown and Co. p.322-328.

Men on polar expeditions were not entirely dependent on the rhythm of organized communities. Their times of going to sleep and getting up varied greatly,

especially during the mid-winter (continuous darkness) and mid-summer (continuous light). There were no differences attributable to season, cold or physical activity. The winter months were characterized by many interruptions of sleep and taking of naps. There was no relationship or coincidence between interrupted sleep and naps. Though men were at liberty to sleep almost as long as they wished, the mean duration of sleep was approximately eight hours.

165. LEWIS, P.R. and M.C. LOBBAN. 1967.
Dissociation of diurnal rhythms in human subjects living on abnormal time routines.
Quart. J. Exp. Physiol. 42:371-386.

Twelve human subjects lived as 2 isolated communities in Spitzbergen, 1 group living on a 21 hour routine and the other on a 27 hour routine. Recordings were made of body temperature and of the excretion of water, chloride and potassium. The temperature rhythm adapted almost immediately to the abnormal routines in 11 out of the 12 subjects, in marked contrast to the excretory rhythms, which adapted immediately in only 3 subjects. On the abnormal routines, small but statistically significant differences between the excretory rhythms for water, chloride, and potassium were very common and marked dissociations were not uncommon. The usual type of marked dissociation observed was that in which the rhythm of potassium excretion was out of phase with those of water and of chloride, with the potassium excretory rhythm showing more evidence of the persistence of an inherent 24 hour component. It is suggested that there must be more than one mechanism controlling physiological diurnal rhythms in man. One such mechanism is almost certainly central; the possible location of other mechanisms is discussed.

166. LILLE, F. 1967.
Le sommeil de jour d'un groupe de travailluers de nuit.
Travail. Hum. 30:85-97.

167. LITSOV, A.N. 1969.
Experimental study of the diurnal periodicity in physiological functions and human performance during disruption of sleep and wakefulness patterns.
Space Biol. and Med. 3(4):85-96.

A drastic alteration of work and rest cycles caused a gradual restructuring of physiological functions and the performance pattern of six healthy pilots used as test subjects. The restructuring included three stages: latent, apparent and deep. The rate with which different functions of the human body adjusted to a new environment varied: the EEG and simple motor reactions changed with the highest rate whereas autonomic functions and highly coordinated mental activity changed with the lowest rate. The restructuring of diurnal periodicity under experimental conditions was considerably affected by the pattern of physical and mental activity and the sleep of the test subjects and their motivation. The dynamics of restructuring of physiological functions, performance and sleep of human beings should be considered as the best indication of human adaptation to an altered pattern of their activity. (Author)

168. LOBBAN, M.C. 1967.
Daily rhythms of renal excretion in arctic-dwelling Indians and Eskimos.
Quart. J. Exp. Physiol. Cog. Med. Sci. 52(4):401-410.

The daily rhythms of renal excretion of indigenous arctic subjects were recorded under natural conditions during the continuous darkness of mid-winter (Indians only). The excretory patterns for water, K, Na and chloride were compared with those of a group of British control subjects, recorded when they were newly introduced into a summer arctic environment in adult life. In general, the excretory patterns of the arctic subjects contain a high proportion of abnormalities, such that the averaged patterns for the indigenous groups are less well defined than are those for the control group of subjects from a temperate zone. The loss of definition of the rhythms is most marked in the Eskimo subjects, where differences between day and night excretory rates have virtually disappeared. Mathematical analysis of the individual results shows that the relative amplitude of the rhythm of K excretion decreased from British controls → summer Indians → winter Indians → summer Eskimos. The differences between control subjects and all indigenous subjects and between Indians and Eskimos are significant, and cannot be accounted for by variations in age, activity pattern or diet. It is suggested that the normal daily alternation of light and darkness in the environment is important not only for the day-to-day maintenance of renal diurnal rhythms but also for the initiation and full expression of these rhythms in the early life of the human subject. (Author)

169. LOBBAN, M.C. 1965.
Dissociation in human rhythmic functions.
In: J. Aschoff, ed. Circadian Clocks, p. 219-227. Amsterdam, North-Holland Company.

The dissociation in human rhythmic functions, such as excretion of water, potassium, sodium and chloride in patients and normal subjects exposed to variations of light-dark periods, indicate that light is an important Zeitgeber in the synchronization of circadian rhythms in man. But the anomalies in the observations concerning the excretion of potassium, in particular also indicate that light is not the only factor so involved. Much more work is needed upon the human subject in different environmental conditions and on different work schedules before the roles of environmental and social factors and the activity pattern in the maintenance of the normal human physiological daily rhythm can be fully evaluated. (Cir. Rhy. Bibl. by Heller)

170. LOBBAN, M.C. 1963.
Human renal diurnal rhythms in an Arctic mining community.
J. Physiol. 165(2):75-76.

It was previously thought that the diurnal rhythm of potassium excretion is, among renal rhythms, the most resistant to change. However, a study of renal diurnal rhythms in a Norwegian arctic mining community indicates that potassium rhythm can be changed under certain conditions. The renal diurnal rhythms of 35 subjects were observed for 6 months, including miners working day and night shifts, day shifts above ground only, and night shift

only. The diurnal excretory patterns for day-shift workers became disorganized and/or diminished in amplitude during the dark months. The effect was more pronounced for water than for potassium. There was some improvement at the spring equinox. The night-shift workers showed a reversed pattern in terms of a normal 24-hour period, i.e., the excretory patterns for water was disrupted during the dark months, but the excretion of potassium was entrained to the activity pattern from the outset. (M.W.)

171. LOBBAN, M.C. 1965.
Time, light and diurnal rhythms.
Symp. Zool. Soc. London 13:351-386.

The experimental observations described in this chapter demand a double system for the control of kidney function, one part of which is primarily concerned with the excretion of water and of moderate lability in most subjects and the other with the excretion of potassium and resistant to environmental changes. Such a double mechanism does exist in the body. The mineralocorticoids of the adrenal cortex are vital for preserving the normal mineral balance of the body, but it is not known how the separation between the rhythms of excretion of Na and K is brought about. It is unlikely that the maintenance of the physiological diurnal rhythms in man could have a direct effect upon the chances of the individual's survival under civilized conditions, but it is reasonable to suppose that if his physiological processes are well entrained to a normal 24 hour day, and he is then asked to be alerted during the period of minimal physiological function, some strain will result. This will certainly be so if similarly entrained diurnal rhythms of performance and efficiency are also involved. (L.M.)

172. LOBBAN, M.C. and H.W. SIMPSON. 1961.
Diurnal excretory rhythms in man at high latitudes.
J. Physiol. 155(2):64P-65P.

The pattern of water excretion for all three subjects travelling from Bergen to Tromso in May became disturbed as soon as the party approached the latitudes of continuous summer daylight. This disruption in the amplitude of the rhythm was accompanied by a considerable diminution in the amplitude of the rhythm, the dimunition being especially marked about the latitude of the Arctic Circle. After 3 weeks at high latitudes, however, both phase and amplitude of the rhythm of water excretion had returned to normal. In direct contrast, the pattern of potassium excretion remained normal throughout the whole journey. These observations suggest that the mechanism for diurnal variations in water excretion is to some extent under the influence of environment factors, such as light.

173. LUTWAK, L., C.D. WHEDON, P.A. LACHANCE, J.M. REID and H.S. LIPSCOMB. 1969.
Mineral electrolyte and nitrogen balance studies of the Gemini-VII fourteen-day orbital space flight. 1969.
J. Clin. Endocrinol. Metab. 29(9):1140-1156.

An effort was made to perform complete metabolic balance studies of 2

astronauts during a 10-day pre-flight control phase, 14 days of orbital space flight (NASA Gemini-VII), and 4 days of post-flight recovery phase, measuring dietary intakes and excretions of Ca, Mg, phosphate, sulfate, Na, K and chloride. In addition, urinary excretions of 17-hydroxycorticosteroids, aldosterone and catecholamines were measured in the same subjects. Considerable interindividuality variability was demonstrated in all experimental indices measured. In one man, significant increases in urinary Ca occurred during the 2nd week of flight, and persisted during the recovery phase; Ca balance became less positive in flight in both subjects. Urinary phosphate excretion increased substantially in flight in both subjects despite reduction in phosphate intake. Urinary N and sulfate excretion decreased in flight but less than would be expected from the reduction in intake. Patterns of excretion of Mg, Na, K and chloride were different for each subject and could in part be correlated with changes in adrenocortical steroid production. The principal hormonal change was a striking decrease during flight in the urinary excretion of 17-hydroxycorticosteroids. Dermal losses of Ca, Mg, sulfate, N and phosphate were insignificant during all 3 phases.

174. MARTEL, P.J., G.W.G. SHARP, S.A. SLONACH and H.S. VIPOND. 1962.
A study of the roles of adrenocortical steroids and glomerular filtration rate in the mechanism of diurnal rhythm of water and electrolyte excretion.
J. Endocrinol. 24:159-162.

1. An investigation of the mechanism of diurnal excretory rhythms has been carried out on four healthy male subjects in whom the excretory rhythms were reversed by a 12 hr. shift of the activity-sleep and light-dark schedules. 2. The diurnal rhythms of water, sodium, potassium, creatinine and ketogenic steroid excretion adapted to the reversal of routine at different rates. 3. It is concluded, from the dissociation of these rhythms during the reversal phase, that the ketogenic steroids are not controlling either the major variation of glomerular filtration rate or the excretory rhythms of water and sodium. 4. The potassium excretory rhythm appears to be linked with the ketogenic steroid rhythm. 5. The mechanism of the diurnal rhythm of urine flow is discussed in relation to these findings.

175. MIASNIKOV, V.I. 1967.
(Effect of altered daily activity schedule on the human organism during confinement.) Vliianie izmeneniia rezhima sutochnoi delatel'nosti na organizm cheloveka v usloviakh izoliatsii.
In: N.N. Gurovskii, ed. Ocherki Psikhofiziologii Truda Kosmonavtov, p. 107-125. Moscow, Izdatel'stvo Meditsina.

The author underlines the importance of a carefully organized work and rest schedule for cosmonauts and points out the difficulty of the task. He then describes a series of confinement experiments with different work and rest schedules and discusses the physiological and neuropsychological effects. Changes in physiological functions producing fatigue, poor sleep, reduction of working capacity, slowness of reaction, dozing during working time and hallucinations, could seriously impair the fulfillment of a mission. In order to make any given schedule effective, means should be found to keep the duration and depth of sleep under control. (ATD/LC)

176. MIKUSHKIN, G.K. 1969.
(Circadian rhythms and their significance for space biology and medicine.) Tsirkadnye ritmy i ikh znachenie dlia kosmicheskoi biologii i meditsiny. Kosm. Biol. Med. 3:32-39.

Description of the characteristic features of circadian rhythms in plants, animals, and humans, and survey of the possible problems resulting from them during space flights. The role of diurnal rhythms in the physiological processes of living organisms is evaluated in terms of the effects which result when they are disturbed. Results of previous studies available in the literature are reviewed. It is suggested that the individual's ability to adapt to changes in the circadian rhythm should be used as a criterion for selecting astronaut candidates. (T.M.) Reprinted from International Aerospace Abstracts, Inc.

177. MILLS, J.N. 1964.
Circadian rhythms during and after three months in solitude underground. J. Physiol. 174:217-231.

A record of times of sleep of a man spending 105 days in solitude underground showed that he fell asleep and woke a little later each day following a sleep-waking cycle of roughly 24-hours. Collection and analysis each week of 36 hour urine in a series of samples showed that potassium excretion followed a similar rhythm. For 8 weeks, excretion of sodium and chloride followed a rhythm similar to that of potassium, but thereafter, they became dissociated from it, and increasingly irregular. Creatinine excretion was always low during sleep. Phosphate excretion always fell about the time of waking. It is maintained that sleep-wakefulness, potassium excretion, and for atime excretion followed a free-running rhythm with cycle length slightly over 24 hours. On emerging the subject spent 3 days in bed in a hospital; during the first 24 hours his potassium excretion followed a circadian rhythm with a maximum about 01.00 hr. whereas during the last 24 hour excretion of potassium, sodium and chloride had returned approximately to normal phase relations. (Author)

178. MILLS, J.N. 1967.
Keeping in step -- away from it all.
New Scientist 33:350-351.

Records are cited of 5 individuals who have sojourned in solitude underground for periods varying between 62 and 153 days. Circadian rhythms are discussed for such physiological functions as body temperature, urinary excretion, sleep-wakefulness, rest-activity cycles, breathing, and hormone production. Endogenous rhythms determined by some form of internal "clock" or exogenous rhythmic fluctuations in the environment are discussed. Endogenous "clock" rhythms can be determined by taking subjects by jet travel half way around the world and observing how long it takes them to adjust to the new time schedules. Subjects can be screened from most climatic rhythms in the continuous daylight or darkness of a polar summer or winter (this is convenient for studies of communities), or deep below ground in a cave (for study of solitary sojourns). Many urinary constituents continue to show a 24-hour rhythm in their pattern of excretion, even after many weeks of life with a "day" of abnormal length. A difficulty in all rhythm

studies is that the variable studied can be affected by many factors besides the rhythmic process. "Free-running" experiments and methods of statistical analysis are discussed. (A.R.T.)

179. MILLS, J.N. 1966.
Sleeping habits during four months in solitude.
J. Physiol. 189:30P-31P.

A subject was isolated underground for 127 days without access to time cues. During the first 2 months his "day", measured from the time of waking to the next time of waking, varied between 19 hours (10 hr. activity, 9 hr. sleep) and 55 hours (18 hr. activity, 37 hr. sleep). The distribution was skew with a mode of 24 to 27 hours. During the last 2 months, the subject exhibited a circadian rhythm with an average "day" of 25.9 hours. Events of the first 2 months are discussed. Statistical analysis of the data for the last 2 months supports the view that the period of approximately 25.9 hours may result from the operation of a biological clock which produces a rhythmic alternation of wakefulness and sleepiness. (A.R.T.)

180. MILLS, J.N. 1967.
Troglodyte dysrhythmia or 130 days underground.
Manchester Med. Gaz. 46:6-8.

The records of 5 individuals who have spent periods of 62 to 153 days in solitude underground are cited. The organization, equipment, and arrangements needed for a study of biological phenomena in the male subject who remained underground for 127 days are described in some detail. Since the original purpose of the stay in the cave was publicity, the scientists, whose studies were not planned for beforehand by the publicity-seeking owners of the cave, were subjected to interviews by the press, radio and television personnel at various times and particularly when the isolated subject was due to emerge from the cave. These events are described in some detail. The scientific results obtained from the study indicated that the subject had lost most of the circadian rhythms which in ordinary circumstances are so persistent in human subjects. The investigation posed more questions and problems for further study. A number of the questions are stated. Needed would be sophisticated recording systems and computer analysis of the data obtained. (A.R.T.)

181. MOHLER, S.R. 1968.
Circadian rhythms and the effects of long-distance flights.
Air Line Pilot 37:15-17.

Description of some of the implications of flights covering a time-zone change of four or more hours between the place of departure and the place of landing, with a special consideration of the effects on circadian rhythms. Since the disruption of the circadian rhythms may adversely affect human performance, a number of studies have been conducted in order to determine the point at which airline pilots become impaired to an unsafe degree. As a result of this study, airline crews were rescheduled with intercontinental flights. To assess biological changes in occupants

not concerned with aircrew duties, scientists conducted tests on a subject who has flown from Minneapolis to Korea. The investigators found that the diurnal biochemical excretion pattern synchronized gradually with Korean time, reaching a time displacement of nine hours from Minneapolis time by the eleventh day, a rate of adjustment of approximately one hour per day. It is concluded that a long-distance traveler should definitely pace himself during the asynchronous period if he wishes to receive the least biological and mental strain. (P.V.T.) Reprinted from International Aerospace Abstracts, Inc.

182. MOHLER, S.R. 1966.
Fatigue in aviation activities.
Aerosp. Med. 37:722-732.

Biological fatigue as a cause of airplane accidents is discussed. The nature of fatigue in human beings is defined and discussed, including factors contributing to both physical and mental fatigue. Flight-time limitations for crew members, as specified in the Code of Federal Regulations, are reviewed. Psychosomatic symptoms of excessive fatigue are discussed. Some interrelationships are described between biochemical, physiological, and psychological factors before, during, and after long-distance jet flights and in Forest Service fire-fighter aircraft flights. Some of the "fatigue-promoting" qualities of different types of aircraft and pilot equipment and the need for improving the environmental circumstances of the air traffic controller are discussed. Seven recommendations are stated in detail for the improvement of currently existing conditions so as to keep fatigue at a minimum under the requisite operational circumstances. (A.R.T.)

183. MOHLER, S.R., J.R. DILLE and H.L. GIBSON. 1968.
The time zone and circadian rhythms in relation to aircraft occupants taking long-distance flights.
Amer. J. Pub. Health 58(8):1404-1409.

Air travelers crossing 4 or more time zones experience significant desynchronization of certain daily biologic rhythms. Until rephasing of the rhythms occurs relative to the solar cycle at the destination, some subjective discomfort and disruption of psychophysiologic responses can occur. This paper reviews research on diurnal rhythms, discusses the implications for aircrew and passengers, and makes recommendations for reducing the effects of time zone displacements. (Authors) Copyright c 1969 Biological Abstracts, Inc.

184. MOLTON, P. 1970.
Biological aspects of long-term space flight.
British Interplanetary Society Journal 23:515-526.

Hydrogenomonas and Chiorella life-support systems for spacecraft are compared and discussed in relation to human requirements and the type of equipment needed to maintain a stable and balanced food supply on long-

duration space missions. Some disadvantages of purely chemical systems are indicated. None of the systems yet tried can provide complete regeneration or utilize solid human waste directly. A possible solution to the problem is the thermal destruction of solid wastes and the use of a series of specific microorganisms in continuous culture, providing flexibility and variety. Possible long-term metabolic effects of space flight on humans are indicated, particularly with regard to circadian rhythms. Possible use of deep hypothermia in space is discussed. (Author)

185. MOSSO, U. 1887.
Recherches sur l'inversion des oscillations diurnes de la temperature chez l'homme normal.
Arch. Ital. Biol. 8:177-185.

186. MYASHIKOV, V.N. 1968.
Circadian rhythm of physiological functions in man under conditions of isolation.
Aerosp. Med. 28:73-78.

To determine the effect of different daily routines (normal, inverted, and split) on the circadian rhythm of heart rate, respiration, and temperature, isolation chamber experiments were conducted on healthy young males. An analysis of the results shows: (1) Functional changes were caused by the simultaneous action of isolation, restricted motor activity, and change in normal alternation of periods of wakefulness and sleep. (2) Distortion of normal living routines changed the circadian rhythm of some physiological functions. The reconstruction of respiration in accordance with the split routine occurred as early as the sixth day of the experiment. (3) Prolonged hypodynamic (15 days) gave rise to signs of poor physical condition with a corresponding increase in the heart rate (by 10 to 20 beats) toward the end of the experiment, and to a decrease in functional adaptability to physical exercise thereafter. (M.G.J.) Reprinted from STAR.

187. NAGASAKA, T., S. ANDO, M. HARA and K. TAKAGI. 1967.
Adjustment of the diurnal rhythm in body temperature by a transposition across the longitudes with a moderate speed.
Nagoya J. Med. Sci. 29(4):369-375.

Diurnal rhythm in body temperature and heart rate of 12 healthy athletes were recorded during a trans-Pacific voyage from Japan to the west coast of the United States. The speed of the ship was 14-16 knots which caused shortening of the actual length of a day by 32 min. The ratio of the lag of change in diurnal body temperature rhythm did not seem to be constant throughout the voyage. The adjustment of the rhythm was new local time seemed to occur slowly during the first few days but fairly after the 2nd week on the ship. During the voyage the rhythm was approximately 2 hr. behind the typical temperature rhythm of the local time, and the rhythm could follow the new environmental routines in 3 or 4 days after arrival in the USA. The results obtained suggest that the intrinsic biological rhythm formed during a longer period of time greatly resists distortion by a new environ-

mental rhythm even with moderate speeds in trans-position. (Authors)

188. NICHOLSON, A.N. 1972.
Duty hours and sleep patterns in aircrew operating world-wide routes.
Aerospace Med. 43(2):138-141.

Sleep patterns of an airline pilot operating world-wide, east-west routes have been related to duty hours. It is suggested that duty hours compatible with an acceptable sleep pattern may be related in a logarithmic manner with the number of days of the schedule. It would appear that the most critical consideration in preserving a control sleep pattern may involve the relation between total duty hours and duration of schedule.

189. NICHOLSON, A.N. 1970.
Sleep patterns of an airline pilot operating world-wide east-west routes.
Aerospace Med. 41(6):626-632.

The sleep patterns of an airline pilot operating long haul east-west routes have been observed over a period of eighteen months. The normal sleep pattern was modified by irregular duty periods and by adaptation to time zone change. It is considered that sleep disturbance rather than sleep deprivation is the main problem in such aircrew. The physiological significance of the sleep patterns experienced during route flying is not understood, but it would appear possible that complex adjustments of intra-sleep cycles and short periods of sleep (naps) may provide an adequate sleep pattern.

190. NICOLAS, M.J. 1967.
(Biological rhythms and long distance air travels.) Rythmes biologiques et voyages aeriens a longue distance.
Rev. Corps Sante Armees 8(5):637-646.

Local time represents a powerful synchronizer of human circadian or nychthemeral rhythms. A true temporal disorientation occurs when after a supersonic flight from east to west as from Paris to Tahiti the local time synchronizers indicate the hour is midnight and the internal physiological clock indicates that the hour is noon. Biological adjustment of the sleep-wakefulness cycle and other rhythms may take several days in the extreme example cited but such adjustments occur more rapidly when the time-zone change has been only five or six hours. Long distance voyages by ship are sufficiently slow to allow a continuing physiological adjustment to time-zone changes. With supersonic air travel, New York being only three hours from Paris, the pilot could make a round trip in the same plane on the same day and suffer no disorientation of his biological rhythms. (A.R.T.)

191. OGATA, K. and T. SASAKI. 1963.
On the causes of diurnal body temperature rhythm in man, with reference to observations during voyage.
Jap. J. Physiol. 13:84-96.

The study reported was made from data collected during an eastward sea

voyage of 49 days from Germany to Japan. The days averaged 23 hours 40 minutes in length. Oral temperature, local time, latitude, longitude, time of sunrise and sunset, degree of swell of the ocean waves, and grade grouping of the waves (calm, smooth, rough sea, high sea, etc.), were all recorded. Influence of pitch and roll as evidenced by varying degrees of the author's seasickness was also recorded. The time of morning rise in body temperature correlated more nearly with local time than with the time of sunrise, and although it was suppressed considerably during bouts of seasickness, it did not disappear. On another voyage (across the Pacific from Japan to San Francisco) the days averaged 23 hours 25 minutes. The temperature curves suggested a transitory process of adaptation to a new periodicity and phase. Observations are discussed of non-24-hour regimes and underground living in a mine. (A.R.T.)

192. OHARA, K. 1967.
A report of the circadian rhythm of body temperature during a longitudinal air travel.
Nagoya Med. J. 13:143-149.

The report concerns a study upon the diurnal rhythm of body temperature during a round trip made mostly by air from Japan to London which was conducted on the author during a trip to attend a scientific meeting in London. Lag time of the shift from the Japanese to the English rhythm was found to be 10 to 12 days, while that from the English to the Japanese rhythm was 7 days. The speed of the adjustment was suggested to be different according to whether the subject is transported from his native land to a foreign one or in the reverse direction. Dispersions were observed between the temperature and activity cycles after rapid transpositions across the longitudes, indicating that the two oscillators are differently coupled.

193. OSBOURNE, W.A. 1908.
Body temperature and periodicity.
J. Physiol. (London) 36:39P-41P.

194. PAFNOTE, M., I. MIHAH, A. IULIA VAIDA, O. LUCHIAN, and G. PATRU. 1969.
The dynamics of some physiological reactions in miners during the three work shifts.
Igiena 18(11):656-661.

Investigations on the physiology of shift work were carried out before and after work in 166 miners, of whom 51 were on the morning shift, 58 on the afternoon shift and 57 on the night shift, determining pulse rate, blood pressure in clinostatism and 2 minutes after orthostatism (the Crampton index), resting metabolism, neuromuscular excitability (intensity-duration curves) on the opposing thumb-middle finger couple, optical rheobase and attention. Results showed a more accentuated fatigue at the end of the afternoon shift, reflected in the higher optical rheobase values, in the unfavorable alterations of the intensity-duration curves and cardiovascular reaction in the orthostatism test expressed by a decrease in the Crampton index. Evidence was found of a tendency towards adaptation to work in the night shift, reflected by changes in the reactions of the CNS and of certain vegetative functions. (K.M.E.)

195. PANFEROVA, N. YE. 1964.
(Diurnal rhythm of functions in humans during restricted mobility.) O sutochnom ritme funksiy cheloveka v usloviyakh ogranichennoy pdvizhnosti.
Fiziol. Zh. 50(6):741-749.

Changes in diurnal periodicity of certain functions of human muscle activity under conditions of maximum restriction are studied. It is found that under these conditions the customary diurnal rhythm of body temperature changes. The body temperature remains at one level for a long period of time, and then changes abruptly. The change in diurnal fluctuations of pulse rate, breathing, and blood pressure was less pronounced than the change in body temperature fluctuations. (Author)

196. PARIN, V.V. and E.B. SHULZHENKO. 1969.
Applying the principles of physiological modeling in space biology and medicine.
Aerosp. Med. 40:242-244.

Discussion of an evolutionary approach to the problems of space physiology through the development of comparative research methods. The means by which mathematical, physical, and physiological modeling can be combined for the analysis of functional changes during varying gravity conditions are elaborated. The method is applied to a study of the effects of transverse accelerations on cardiovascular changes and their relation to hemodynamic shifts of pulmonary circulation. The results obtained under centrifuge and modeling conditions were similar. It is concluded that a study of the evolution of a given function makes it possible to establish the development of structural and functional shifts in the circulation apparatus, their sequence, and the process by which regulatory mechanisms are reconstructed, as well as to reveal their dependence on new gravity conditions. (B.H.

197. PARIN, V.V. 1968.
Paths of development of space physiology.
Space Biol. Med. 2(1):3-11.

A discussion of USSR scientific and technological achievements in the area of astronautics is presented. In the area of space medicine and biology, various investigations have been performed with the employment of satellites to study the effects of space flight factors on the functions of organisms. The development of life support-systems for the regeneration of oxygen and water in spacecrafts are considered; the use of algae as a supplier of oxygen, as well as being a food source, will be significant in long-term space flights. Also, the utilization of microorganisms and yeasts for purposes of human and animal nutrition are discussed. The problem of biological rhythms is of great significance for space biology. The role of biological rhythms in the maintenance of homeostatic reactions of the organism under long space flight conditions has taken on particular significance in space physiology. Studies of the effects of stress factors encountered in space flight on the adaptive mechanism of organisms, and the methodological approaches used to analyze these changes are discussed.

198. PARIN, V.V. 1968.
Principles of medical control during long-term spaceflights.
Space Biol. and Med. 2(4):99-102.

Long-term manned spaceflights can be made on the basis of development of an essentially new medical control methodology. A possible application of on-board computers for the processing of medical information is discussed. The regular periodicity of the measurements made during long-term spaceflights and their program are discussed. Some new methods for physiological examinations of space-crew members are presented. The authors show that the humoral medium of the human body and space-cabin hygienic parameters must be checked. They stress the importance of study of diseases which may occur during spaceflight, training of physicians for such flights and prediction problems. (Author)

199. PARIN, V.V., F.D. GORBOY and F.F. KOSMOLINSKII. 1967.
Space psychology.
Foreign Technology Div. Wright-Patterson AFB, Ohio. 15p Rept no. FTD-HT-23-1067-67. Edited trans. of Priroda (USSR) n12 p3-12 1966, by F. Dion.

Soviet and Western concepts of the selection and training of cosmonauts, effects of isolation, psychophysiological stress, and biological rhythms in space are reviewed. (Author)

200. PARKER, G.W. and B.O. HARTMAN. 1965.
Human adaptability to military space systems.
Air. Univ. Rev. 12:29-40.

Review of the problems of human adaptability to space flight. The early orbiting of organisms, animals, and humans is considered, and hostile environmental factors and costs of space missions are discussed. The physiological problems caused by gravity, weightlessness, acceleration, and impact are studied, and experimental results pertaining to these problems are examined. Such psychological problems as emotional alterations in response to unusual environments, optimal work/rest schedules, and maintenance of efficiency over long periods of time are surveyed, and the overall concept of the utility of man inspace is analyzed. (B.B.)

201. PITTENDRICH, C.S. 1967.
Circadian rhythms, space research and manned space flight.
In: A.H. Brown and F.G. Favorite, eds. Life Sciences and Space Research, V., p. 122-134. Amsterdam, North-Holland Publishing Co.

Summary of the principal generalizations about free-running circadian oscillations. The circadian period of the free-running oscillation in rodents is discussed, and the nature of the driving oscillation as related to space research is considered. Finally, the physiology of circadian organization and its relation to manned space flight is investigated. (B.B.)
Reprinted from International Aerospace Abstracts, Inc.

202. POEPPEL, E. 1968.
(Desynchronization of circadian rhythms within an isolated group.)
Desynchronisationen circadianer rhythmen innerhalb einer isolierten gruppe.
Pflugers Arch. Gesamte. Physiol. Menschen Tiere. 299(4):364-370.

In order to test whether social interaction is sufficient for synchronization

of circadian rhythms, a group of 4 male subjects was isolated. The subjects lived for 3 weeks under constant conditions in an underground bunker. For each subject were measured: periods of sleep and wakefulness, volume (ml/hr.) and concentration of electrolytes of each urine sample and body temperature during sleep. On several days the subjects were tested with psychological questionnaires. During the first half of the experiment, the subjects lived synchronized with each other; they had an average activity period of 26.2 hr. In the second half of the experiment, 3 subjects lengthened their activity period to 27.2 hr. One subject lived with a shorter activity period (24.1 hr) desynchronized from the group. The increase of body temperature during sleep and the course of urine excretion, which is interpreted as beat, indicated that this subject was in fact synchronized in his activity period with the group during the first half of the experiment, but that the rhythm of the vegetative functions was free running with another (internal desynchronization).
(Author)

203. POEPPEL, E. 1968.
(Inter- and intra-individual desynchronization in an isolated group.)
Inter- und intraindividuelle desynchronisation innerhalbeiner isolierten gruppe.
In: Johann-Wolfgang-Goethe-Univ. Extraterrest., Biophys., Biol. and Space Med., p. 267-274. Frankfurt, West Germany, Johann-Wolfgang-Goethe-Universitat.

An experiment is described in which four male human subjects were isolated as a group for three weeks. Recorded were the periods of activity and rest, electrolyte concentration in urine, body temperature, and psychomotor tempo. Various socio-psychological tests and self-appraisals were also conducted. The spontaneous periodicity of the subjects was compared with the normal 24-hour-day rhythm, and the test data were evaluated for the ability of the individuals to live as a group. Translated by K.W.

204. PRESTON, F.S. and S.C. BATEMAN. 1970.
Effect of time zone changes on the sleep patterns of BOAC B.707 crews on world-wide schedules.
Aerospace Med. 41(12):1409-1415.

This paper discusses a study of sleep patterns carried out on pilots of the Boeing 707 fleet of British Overseas Airways Corporation on world wide schedules. Rapid transit of multiple time zones produces disruption of normal sleep patterns which, in itself, is probably one of the greatest problems facing airline pilots. The nature of sleep is examined and the practical problems surrounding the use of hypnotics are noted.

205. RABOUTET, J., G. BOSQUET, E. GRANOTIER and R. ANGIBOUST. 1958.
(Sleep problems and routine pattern of life changes among flying personnel carrying out long distance flights.)
Med. Aeronaut. 13:311-322.

Rhythmic changes in the human physiology produced by rotation of the Earth are named night-and-day cycles. Aircrew flying over several time zones suffer from incessant transformations of these cycles, the most objective symptoms of which are sleep troubles. Changes in routine pattern of life

among aircrew are examined after a study of biological cycles of animal life and namely night and day cycles, the acquired origin of which appears probable. The authors have summarized one hundred case histories of aircrews flying either the Far East or the North Atlantic lines. Sleep troubles are very frequently noted (78% of the cases), and appear as soon as the absolute value of the time changes exceeds 4 to 5 hours. These symptoms are experienced again on the homeward flights. Several factors increase these symptoms: purely individual ones exert only a secondary influence; on the contrary, extraneous factors connected with flight (direction of travel around the globe, weather) or with stop-overs, are important. The consequences of these changes for the body are now considered: diurnal cycles, weight variations and, above all, nutrition troubles due to the upsets of digestive conditioned reflexes. Among various changes in routine pattern of life, sleep troubles are most important: their frequency and the lack of organic adjustment are the most important factors of airman fatigue. The advent of airliners flying ever faster can bring on an aggravation of these problems.

206. REINBERG, A. 1969.
(Evaluation of the circadian desynchronization at the time of transmeridian flights.) Evaluation de la de desynchronisation circadienne lors de vols transmeridiens.
In: Reunion de Chronobiologie Applique a 1'Hygiene de 1'Environment, June 30-1 July, 1969. p. GI-9. Paris, Fondation A de Rothschild.

The role is discussed of environmental and social-ecological (work-rest) factors which serve as synchronizers of circadian rhythms in man. After crossing many time zones or meridians in an airplane flight, a change in phase of certain physiologic rhythms may occur and itself become a synchronizer. The length of time needed for resynchronization varies from one subject to another for a given function and varies within the same subject for the several functions involved. For example, in the same subject it may take 5 days for resynchronization of the circadian rhythm to be established with regard to rectal temperature and more than 3 weeks with regard to urinary excretion of 17-hydroxycorticosteroids. The duration of the resynchronization varies with the direction of flight; it is longer for west-east and shorter for east-west flights (for the same function in the same subject). (A.R.T.)

207. REINBERG, A., F. HALBERG, J. CHATA and M. SIFFRE. 1966.
[Thermic spectrum (rhythms of rectal temperature), in an adult woman before, during and after her isolation underground for three months.] Spectre thermique (rhythmes de la temperature rectale) d'une femme adulte avant, pendant et apres son isolement souterrain de trois mois.
Compt. Rend. Acad. Sci. (Paris) Ser. D. 262:782-785.

A woman aged 26 years spent 88 days underground in feeble light and absence of any known synchronizers. In normal circumstances before the experiment the rectal temperature showed a circatrigintan rhythm of 29 days. During her isolation, spectral analysis (method of least squares) showed: 1st, that the thermal rhythm persisted; and 2nd, that the circadian period increased from 24 hours to 24.5 hours while the circatrigintan rhythm was shortened from 29 days to 25.9 days. The results are shown in a table and in graphs. No generalizations are attempted because this study involved only one subject. (A.R.T.)

208. RENNER, M. 1955.
Ein transozeanversuch zum zeitsinn der honigbiene.
Naturwiss 42:540-541.

209. RUFF, S. 1966.
(The effects of time differences on the human organism in present subsonic and supersonic transport.) Uber die folger der zeitverschiebung auf den menschlichen organismus bei heutigen flugzeugen und uber schallflugzeugen.
Flugwelt 18(10):811-813.

210. RUFF, G.E. 1965.
Space medicine.
Medical Times 93:353-360.

Contributions from almost all medical disciplines are required to prepare humans for space travel. Among the problems which must be solved, the following are prominent: the effects of gravitational pull, noise, vibration, extreme temperature, and extraterrestrial radiation, food and oxygen supply, removal of carbon dioxide and of digestive waste, the effects of toxic fuels, and the effects of altered day-night cycles and of physiological stress. Selection of the crew, training, and direct medical support must be included in the responsibilities of the medical personnel. Prelaunch, inflight, and post flight periods require especially close supervision to insure physical and emotional stability. The early mission have demonstrated that man has the capacity for space flight; but the limits of this capacity have not yet been fully explored.

211. RUMMEL, J., E. SALLIN and H. LIPSCOMB. 1967.
Circadian rhythms in simulated and manned orbital space flight.
Rass, Neurol. Veg. 21:41-56.

This paper presents some results of changes in human circadian rhythms during different environmental conditions. Heart rate, body temperature, urinanalysis, and vigilance and time persistence tests were sampled during the isolation experiments; heart rate was recorded from the two longest Gemini flights. The overall response of several subjects during adaptaion to the experimental chambers showed that some shortened their circadian periods, whereas others lengthened theirs. In some instances different rhythms were observed to shift in different directions. Heart rate showed a well- synchronized 24-hour period which served to point out its quick response to the actual activity pattern of the organism. In-flight data on heart rate showed a reduced circadian componentwhich became more desynchronized the last 4 days of the flight. Drifts in the sleep cycle, producing a period shorter than 24 hours, were also observed. The data on all parameters were graphically presented.

212. SASAKI, T. 1964.
Effect of rapid transposition around the earth on diurnal variation in body temperature.
Proc. Soc. Exptl. Biol. Med. 115:1129-1131.

Body temperature measurements were made about 5 times daily for a period of 2 weeks in a family of 3 including a 6-year old child during and after

a flight from Tokyo to Lexington, Kentucky (an advance of 10 hours in local time) with a 23-hour stopover in Hawaii and 4 days in Seattle. The diurnal pattern of body temperature was also observed in Lexington during June and July and again during December and January. Distinctive characteristics of the temperature pattern of each subject are shown in figures. Adjustments to new local times took place slowly during the first few days and more rapidly thereafter. In the adults the average rate of adjustment was 50 minutes per day for one and 39 for the other, while in the child the rate was much higher. Adjustment of diurnal rhythm to a new local time is discussed in relation to the speed of transposition. (A.R.T.)

213. SCHAEFFER, K.E., B.R. CLEGG, C.R. CAREY, J.H. DOUGHERTY, JR., and B.B. WEYBREW, 1967.
Effect of isolation in a constant environment on periodicity of physiological functions and performance levels.
Aerosp. Med. 38:1002-1018.

Two subjects were kept in an environment of controlled light intensity, noise level, temperature, humidity, and barometric pressure for a 4-day control period, 9 days of isolation and a 3-day recovery period, during which pulse rate, respiratory rate, skin temperature, basal skin resistance and two channels of electroencephalograph (EEG) tracings were continuously monitored. Urine and saliva were collected 4 or 5 times daily and psychomotor tests (hand steadiness, aiming, and two-hand coordination) were carried out twice daily. This experiment was designed to determine, among other things, whether the free running of physiological functions has effects on performance levels, and whether specific phase relationships of circadian rhythms of physiological functions are maintained or lost during the shift of the sleep-wakefulness cycle or in responses to stress. The two subjects reacted to the constant environment in an opposite way; they were of different body build and had different personality trait configurations. The findings in the several parameters studied are discussed at length. It was concluded that temporary predominance of 6-hour frequencies in respiratory rate and 12-hour frequencies in heart rate, body temperature and basal skin resistance of both subjects during the isolation and recovery periods indicate that the whole spectrum of frequencies was affected by the loss of circadian environmental time givers in these subjects. Performance levels did not decrease during isolation but showed a tendency to improvement. Both subjects performed, in general, better in the afternoon than in the morning, but in the recovery period this sequence was reversed. (A.R.T.)

214. SCHREUDER, O.B. 1966.
Medical aspects of aircraft pilot fatigue with special reference to the commercial jet pilot.
Aerospace Medicine 37:1-48.

Analysis of various aspects of aircraft pilot fatigue for determining the severity of the problem, including the medical implications of socio-economic and off-duty activities. It is concluded that the occurrence of pilot fatigue as defined is not common in the airline pilot, that in the same age bracket the airline pilot is healthier than the general male

population, and that there is nothing to indicate that flying the turbojet is deleterious to health or conducive to premature aging. It can also be stated that the circadian rhythm is a definite physiological phenomenon. Nevertheless, there is some adaptation, and additionally, a major percentage of the pilot group experience very little difficulty in compensating for this phenomenon. (M.M.) Reprinted from International Aerospace Abstracts, Inc.

215. SERKOV, P.M. and R.F. MAKUL'KIN. 1969.
(Synchronizing and desynchronizing systems of the cerebrum.) Sinkhronizuiuchi i desinkhronizuiuchi sistemi golovnogo mozku.
Fiziol. Z. 15:699-707.

Survey of available experimental data confirming the presence of separate systems which synchronize electrical activity in the cerebrum. The most important systems consist of the corticothalamic synchronizing system and the reticular desynchronization system. The activity of these systems is closely associated with the archipaleocortex and plays a role in the mechanism of sleep and wakefulness. (T.M.) Reprinted from International Aerospace Abstracts, Inc.

216. SHARP, G.W., S.A. SLONACH and H.S. VIPOND. 1961.
Diurnal rhythms of keto and ketogenic steroid excretion and the adaptation to changes of the activity-sleep routine.
J. Endocrinol. 22:377-385.

1. An investigation of the diurnal rhythms of keto- and ketogenic steroid excretion has been carried out in four human subjects. The subjects lived, under standardized conditions of diet, activity and lighting, in Spitsbergen where 24 hr. daylight persists during the summer. 2. A study of the adaptation of their rhythms to a reversed activity-sleep and light-darkness schedule has been made, and of the subsequent re-adaptation to normal schedules. 3. Adaptation of the ketosteroid rhythm occurred in 2 days and of the ketogenic steroid rhythm in 8 days. 4. The ketosteroid excretory rhythm may depend immediately, and the ketogenic steroid rhythm ultimately, upon habit and environment. 5. Evidence has been presented to suggest that the ketogenic steroid rhythm is dependent upon the synchronization of pituitary and adrenal responsiveness. During the reversal of rhythm, adrenocortical activity takes place initially in the early 'evening' and 'night', occurring progressively earlier each day until it synchronizes with the new time scale. 6. The significance of these findings is discussed.

217. SHARP, G.W. 1961.
Reversal of diurnal temperature rhythms in man.
Nature 190(4771):146-148.

The effects of sudden reversal of the activity-sleep and light-darkness schedule on the diurnal body temperature rhythms of human subjects are described. During the experiment (made in Spitsbergen during the summer months), the activity, diet, time of meals, and the time of retiring and arising were controlled, and the subjects slept with blindfolds on to ensure the alternation of light and dark. Reversal of the diurnal temperature pattern occurred in 3-4 days. It is felt that temperature variations

depend ultimately on habit and environment with light as the most likely controlling stimulus. (Cir. Rhy. Bibl. by Heller)

218. SHARP, G.W. 1960.
Reversal of diurnal rhythms of water and electrolyte excretion in man.
J. Endocrinol. 21:97-106.

Six healthy, male subjects, ages 21 to 23, were studied under Arctic summer conditions of 24 hours daylight in Spitsbergen, Norway. Records were kept of light intensity, temperature, barometric pressure, and weather. Urinalysis was made of volume, specific gravity, pH, and sodium and potassium content for 4 test days during a 12-day control period. Then the subjects arose at 7 a.m., had breakfast, and went back to bed again at 10:30 a.m. They tried to sleep until 7 p.m. when they arose and worked through the night, remaining on this reversed regime for another 12 days. A well-marked diurnal rhythm was seen in the rate of urine production (high day, low night output) during the control period. Specific gravity showed an inverse relationship to the diurnal variation of urine volume. The night urine was more acid than the day urine. Both sodium and potassium showed high day and low night excretion rates. The effects of the reversal of the sleep-wakefulness routine were observed as follows: After 6 days, the familiar pattern of high day, low night output of urine became apparent when the results of all the subjects were averaged. Specific gravity and pH values were reversed in diurnal variation as compared with the control preiod within 3 days for pH and 6 days for specific gravity. From the 6th day after reversal, the pattern of sodium excretion was similar to the control pattern and showed the two peaks of excretory activity in the morning and afternoon. A reversal of the sodium and potassium excretory rhythm was achieved by reversal of the activity-sleep routine. (A.R.T.)

219. SHARP, G.W. 1962.
Persistence of the diurnal rhythm of flow of water.
Nature 193(4810):37-41.

The characteristic rhythm of urinary excretion which is high during the day and low during the night is strongly resistant to change. It is present in the first few weeks after birth and is subject to an extra-renal controlling factor. Six male and 2 female subjects were studied in northwest Spitsbergen where daylight lasts 24 hours each day in the summer. Under controlled conditions of a fixed daily routine and food and fluid intake, urine measurements were made of volume, specific gravity, and pH. After four test days in the control periods, the subjects were placed on a reversed routine which was initiated after waking at 7 A.M. on the 5th day, having breakfast, and then retiring again at 10:30 A.M. They attempted to sleep until 7 P.M. when they arose, had breakfast again and worked through the night. This reversed regime was them maintained for 14 days. The results of the urine studies are tabulated. It was found that a reversal of the rhythm of urinary excretion (volume, pH, and specific gravity) took place in about 6 days and when reverting to the normal routine the rhythm of urinary excretion again became normal in about 6 days time. The individual rates of adaptation of the 8 subjects are compared and discussed. (A.R.T.)

220. SHARPE, M.R. 1969.
Living in space. The astronaut and his environment.
Garden City, New York, Doubleday and Co.

This book opens with an account of early space travels, followed by an explanation of the hazards of space travel, such as temperature extremes, exposure to radiation, sudden decompression, magnetic fields, and weightlessness. Psychophysiological stress, isolation and sensory deprivation, the biological clock, hypothermia and hibernation are next examined. There are chapters on the simulation of space flight and the maintenance of life in space, and explanations of atmosphere-control, water and waste management, and temperature-control systems. There is a consideration of how the astronauts keep in contact with earth and of the importance of space flight to medicine. A final chapter discusses the prospect for future travels in space. There are photographs, many of them in color, figures, graphs, a list of suggested readings, and a subject index. (J.C.P.)

221. SIEGEL, P.V., S.J. GERATHEWOHL and S.R. MOHLER. 1969.
Time-zone effects.
Science 164:1249-1255.

Concepts of physiological cycles, circadian rhythms, exogenous and endogenous periodicities, biological clocks, phase shifts, entrainment of oscillations, zeitgebers (time savers or synchronizers), adaptation to a different timetable (as in daylight saving time), and the effects of changes of the light-dark ratio on the physiological functions of workers on alternating work-shifts are reviewed. The changes associated with rapid geographical dislocations and the interactions between zeitgebers and activity patterns are discussed in some detail. The literature on aerospace "jet age." This review summarizes many of these papers. The travel-time formula developed by the International Civil Aviation Organization to help insure that disturbance in circadian rhythms neither works a hardship nor impairs cerebral function of flight crews on trips to distant places is given and discussed in detail. (A.R.T.)

222. SIFFRE, M. 1969.
(Out-of-time operations in caves.) Operations hors du temp en caverne.
In: B. Hannisdahl and C.W. Sem-Jacobsen, eds. Aviation and Space Medicine, p. 295-299. Oslo, Universitetsforlaget.

Experimental study of the time evolution in several human physiological rhythms and of the associated phenomena of desynchronization and resynchronization in the case of four subjects confined in caves for periods ranging from two to six months. In two experiments a natural alteration from a sleep-wakefulness circadian rhythm to a bicircadian rhythm was found. The bicircadian rhythm can be maintained for several weeks without any damage to the organism, with 34 hours of continuous activity and 14 hours of sleep per cycle. According to the experiments, a circadian-rhythm internal synchronization is observed, or a significant desynchronization, particularly between the central temperature rhythm and the sleep-wakefulness rhythm. (Z.W.) Reprinted from International Aerospace Abstracts, Inc. 1969.

223. SIFFRE, M., A. REINBERG, F. HALBERG, J. GHATA, G. PERDRIEL and R. SLIND. 1966. (Prolonged isolation underground. Study of two healthy adult subjects before, during, and after this isolation.) L'isolement souterrain prolonge. Etude de deux sujets adultes sains avant, pendant et apres cet isolement. Presse Med. 74(18):915-919.

A male subject of 35 years isolated underground for 4 months and a female subject of 25 years underwent isolation in a different cave for 3 months. They reported by telephone to the surface station the hour of going to bed, arising, and eating. The hours when urine was collected were reported. Temperature, pulse and respiratory rates were reported 3 to 6 times while they were awake. The subjects were asked to estimate the duration of short periods of time several times while awake. Clinical examinations were made before and after the sojourn underground. Results are presented in tabular form. By means of the method of least squares, the circadian rhythms of the measured functions were elucidated. Spectral analysis evaluated the predominant rhythms. Electronic computer calculations were used in the analysis. The functions measured included sleep-wakefulness, pulse, respiration, temperature, etc. Free-running rhythms were measured. It was found that circadian rhythms were maintained throughout the isolation underground and that the period of these rhythms was prolonged. Free-running rhythms were desynchronized in relation to local clock time. The results suggest that the circadian rhythms depend, at least in part, on factors that are more characteristic of the organism than of the environment and secondly that environmental factors act as synchronizers. (A.R.T.)

224. SIMPSON, H.W. and M.C. LOBBAN. 1967.
Effect of a 21-hour day on the human circadian excretory rhythm of 17-hydroxycorticosteroids and electrolytes.
Aerospace Medicine 38:1205-1213.

Experimental investigation in which seven fit adult subjects lived from one to seven weeks on a day/night routine lasting 21 hr instead of the usual 24 hr. On alternate weeks all urine was collected (generally every 2 hours) and the serial 17-hydroxycorticosteroids (17-OHCS), potassium, sodium, chloride and water excretion rates were estimated in order to study the effect of this shortened day/night routine on the circadian rhythm of excretion. The results show that adaptation of the 17-OHCS and potassium rhythms took at least five weeks, while for sodium, chloride and water, it tended to be more rapid but was not immediate. These differences in the response of the various rhythms resulted in a loss of their normal synchronization. An interesting finding was that when experimental days fell on periods corresponding to deep sleep periods at home, adaptation was very slow. The fundamental nature of the 24-hr period in the promotion of these excretory rhythms was demonstrated. (M.M.)

225. STRENGERS, T. 1969.
The influence of intercontinental flights on the urinary excretion of steroid metabolites.
In: Reunion de Chrononbiologie Applique a l'Hygiene de l'Environment, p.F1-2. Paris, Fondation A de Rothschild.

There appears to be a close correlation between the parameters of physiological

circadian rhythms and the indices of psychological behavior, physical fitness, and stress resistance. The nature of the mechanism in which the pituitary-adrenal-cortical system is involved in the homeostasis of circadian phenomena was studied by determining the so-called steroid spectra in a number of hourly urine specimens collected after a flight from Amsterdam to Anchorage, to Tokyo. Preliminary results confirmed that stress induces an increase of some metabolic hormonal compounds of adrenal-cortical origin. Most striking, however, was the increase in the excretion of androsterone and dehydro-isoandrosterone and, to a lesser extent, of etiocholanolone. (Modified author summary)

226. STRUGHOLD, H. 1962.
Day-night cycling in atmospheric flight, space flight, and on other celestial bodies.
Ann. N.Y. Acad. Sci. 98(4):1109-1115.

Air and space travel produce asynchrony which impairs efficiency up to a week in moving across time zones. Individuals moving constantly across time zones must maintain the orientation of the zone of domicile to avoid inefficiency. Local time adaptations creates problems for medicine. In space flight artificially determined sleep and wakefulness cycles, exercise, and special regimes of sleep are needed to counteract weightlessness on flights to other planetary bodies. Interstellar exploration presents problems in day-night cycling through the photic environment and time phenomenon. (B.S.)

227. STRUGHOLD, H. 1963.
The physiological clock in aeronautics and astronautics.
Lect. in Aerosp. Med. p.387-400.

The existence of a physiological clock is shown by the fact that all the variations on a system, organ, and cellular level, repeat themselves with a clock-like regularity within the temporal frame of 24 hours. The most reliable indicator of the physiological clock is the body temperature. Man's temperature generally reaches its maximum in the late afternoon, and its minimum in the early morning. In nocturnal animals, such as owls and bats, the temperature curve is reversed. The physiological day-night cycle, synchronized with the physical event of day and night, has become a vital part of human life. This is demonstrated by the fact that breaking this cycle by ignoring sleep for several days leads to neurotic disturbances. Long-distance flights along the latitudes lead to a phase shift between the local day-night cycles of the places of departure and destinations by five to ten hours, but the first is still the physiological day-night cycle of the traveler. This physiological day-night cycle asynchrony may last from three days to one week until the traveler is adapted to the local time. (P.V.E.) Reprinted from STAR.

228. STRUGHOLD, H. 1965.
The physiological clock in aeronautics and astronautics.
Ann. N.Y. Acad. Sci. 134:413-422.

Within the higher range of subsonic speed, and in supersonic speed particularly, a number of time zones may be crossed in a relatively short time. The geo-

graphical time difference is 4 minutes per one meridian, or one hour of one time zone per 15 meridians, making a total of 24 time zones. Man is now capable of traveling at orbital velocity which removes him completely from the realm of geographic time zones. Long-distance flights across meridians lead to a phase-shift between the local physiological day-night cycle at the place of departure and that of the destination. The physiological clock may take up to a week to become adapted to the cycle of the local physical clock. Physiological discomfort may be experienced during the process of resynchronization. In orbital space flights the period, instead of being 24 hours, may be from 80 to 130 minutes, of which about 30 percent, depending on the earth's inclination, is satellite night, or earth-shadow time. In interplanetary space flight, beyond the reach of the earth's full shadow, or umbra, there is constant sunshine and a velvet black sky, or day and night at the same time. The human being in this millieu, however, is still operating under a physiological clock mechanism dictated by his nature as a terrestrial creature. The experiences of American astronauts and Russian cosmonauts are recounted briefly. Conditions on Mars, Venus, and other planets are mentioned. (A.R.T.)

229. STRUGHOLD, H. 1968.
The physiological clock across time zones and beyond.
Air Univ. Rev. 19:28-33.

Discussion of problems of regulating the sleep cycle during manned space missions. The nature of the physiological clock and its cyclic phases are outlined on the basis of the recent results of experimental studies. The stability and changeability of the physiological day-night cycle are discussed. The impact of physiological clock on desynchronization of the physical and physiological cycles in air travel and subsequent readaptation of the individual is described. In regard to space flight, astronauts must follow their internal clock in the arrangement of their sleep and activity regime. This cycle must be isochronous with their natural (inborn) day-night pattern and preferably synchronous with their home time zone. (Z.W.) Reprinted from International Aerospace Abstracts, Inc.

230. STRUGHOLD, H. 1952.
Physiological day-night cycle in global flights.
J. Aviat. Med. 23:464-473.

The physiological diurnal cycle, synchronized with the physical or astronomical periodicity of day and night, has been discussed. Emphasis is made on the persistence of the physiological cycle. This persistence leads to a phase shift of the physical and physiological day-night cycle following long distance flights in east-west or west-east directions. The implications of this phase shift during the incomplete cycle adaptation of the first few days, involving the individuals efficiency, et cetera, has been discussed at some length.

231. STRUGHOLD, H. 1961.
Temporal coordination in intercontinental flights.
Rept. Ross Conf. Pediat. Res. 39:91.

232. STUBBS, P. 1966.
When internal clocks slip.
New Scientist 30:435-436.

This report tells of discussions about the possible adverse effects on air and space travelers when synchronization with the normal day is lost. Experiments on biological clocks and their mechanisms point up the possibility that separate physiological processes could show desynchronization under conditions in which the usual controlling factors are absent. Questions about the maintenance of proper phase relationships are being examined in studies on individuals isolated in underground bunkers where all effects of the Earth's rotation, noise and social interaction can be removed, and artificial cycles can be imposed at unnatural frequencies. Experiments on individuals making long jet flights in easterly or westerly directions are another method of determining effects of altered phase relationships.

233. STUHRING, D. 1963.
The medical aspects of supersonic flights.
J. Amer. Med. Ass'n. 185(1):14-20.

Although no totally new medical problem areas are anticipated for supersonic flight, the speeds and altitudes envisioned do require a reevaluation of the inherent operational and environmental hazards with particular emphasis on potential effects on crew, passengers, and the public at large. The configuration of supersonic jet aircraft is discussed. Since man's sensory modalities are not designed to function at supersonic speeds, delays due to crew reaction time will be critical. The rapidity of events will require automatic sensing and monitoring devices coupled with on-board computers, autopilot, automatic collision avoidance, radioteletype, etc. Of greater clinical concern will be the unique consequences of the pronounced phase shift in the physiological day-night cycle. The 24-hour astronomical cycle which has structured the familiar day-night pattern of work and rest has also imposed, directly or indirectly, a fundamental synchronization of cellular functions in most higher forms of biologic life. In man, the resultant physiological rhythm is manifested by diurnal changes in body temperature, endocrine activity, autonomic tone, electrolyte balance, blood constituents, and other basic phases of metabolism. Examples are cited of phase shifts in biological functions encountered by means of supersonic long-distance flights and the lengths of time required to readjust the metabolic clock to local clock time. Noise levels and cabin pressurization are discussed from the medical point of view of their physiological effects on crew and passengers. Also discussed are physiologic cosmic radiation, ionization of air, and solar flares. (A.R.T.)

234. TIMBAL, J., C. BOUTELIER, J. COLIN, Y. HOUDAS and M. SIFFRE. 1968.
(Rectal temperature rhythm at a free rein.) Le rythme de la temperature rectale en libre cours.
Rev. Med. Aeron. et Spatiale 7:107-114.

Study of the rhythm of the rectal temperature on a subject isolated underground for six months. A maximum temperature difference of 1.2C was observed over one period of three months. The maximum value was 37.2 C, and the minimum value was 36 C. A remarkable maintenance of the circadian rhythm of the

rectal temperature was observed over the entire isolation period. Results of this study are applied to a discussion of long-distance aircraft flights. (M.G.) Reprinted from International Aerospace Abstracts, Inc.

235. TOULOUSE, E. and H. PIERON. 1907.
Le mechanisme de l'inversion chez l'homme du rhythme nycthemeral de la temperature.
J. Physiol. Pathol. Gen. 9:425-440.

236. TRUMBULL, R. 1966.
Diurnal cycles and work-rest scheduling in unusual environments.
Human factors 8:385-398.

This review of the work of others, with liberal quotations from their published studies, embraces some historical background (sundials, Inca sites, Stonehenge), the concept of zeitgebers, biological clocks, endogenous factors, environmental factors, behavioral periodicity, basic physiological rhythms, sensory deprivation experiments, biological conditioning, work-rest cycle relationship to diurnal cycles, performance measures, adjustments to trans-Atlantic flights, entraining or cycle imposition in animals and man, correlation between spontaneous autonomic activity and adaptation, vigilance, arousal, end spurt, expectancy hypothesis, sleep and effects of sleep loss, space flights, and psychological aspect of time. (A.R.T.)

237. TUNE, G.S. 1969.
Sleep and wakefulness in a group of shift workers.
Brit. J. Industr. Med. 26:54-58.

Fifty-two shift workers recorded their hours of sleep and wakefulness for a period of 10 weeks. Compared with matched non-shift-working control subjects it was found that they took a higher average duration of sleep per 24 hours and more and longer naps outside the major sleep period. A comparison of the on and off duty records from the shift workers showed that a sleep debt was incurred during the former which was largely paid off by taking long naps in the latter. It is suggested that the longer sleep taken by the shift workers may be necessary in order to pay off specific kinds of sleep debt.

238. UENO, E. 1961.
Diurnal variation in body temperature of door-keepers subjected to rotation of shifts.
Bull. Res. Inst. Diathet. Med. Kumanto Univ. 70:801-833.

239. VAN LOON, J.H. 1963.
Diurnal body temperature curves in shift workers.
Ergonomics 6(3):267-273.

Observations on body temperature at test of 3 workers inexperienced in shift work presented, when working in dayshift, the normal well-known diurnal curve, and when working in nightshift a pattern significantly

different from the normal one. The 3 subjects showed a striking congruence of curves. During a nightshift period of several weeks in succession every week appeared to involve a new "short-term adaptation" taking one or more days; every weekend in between normal daylite seemed to cause a turn back. There was only little evidence of a "long-term adaptation." (Author)

240. VERNON, J.A. et al. 1961.
The effect of human isolation upon some perceptual and motor skills.
In: P. Solomon, ed. Sensory Deprivation. Cambridge, Harvard University Press.

241. WEBB, W.B. 1965.
Sleep: Effects of a restricted regime.
Science 150:1745-1747.

Eight young male subjects were permitted to sleep only 3 hours out of each 24 for 8 days. Electroencephalographic recordings were made during the 3-hour period of sleep. There was an increase in the amount of deep sleep (stage 4) during this period. On a recovery night, the first 6 hours revealed a significant increase in deep sleep, and beyond this period there was a sharp increase in stage 1-rapid eye movement sleep. (Author)

242. WEGMANN, H.M., H. BRUENER, D. JOVY, K.E. KLEIN, J.P. MARBARGER and A. RIMPLER. 1970.
Effects of transmeridian flights on the diurnal excretion pattern of 17-hydroxycorticosteroids.
Aerospace Med. 41(9):1003-1005.

The urinary excretion of unconjugated 17-hydroxycorticosteroids (17-OHCS) was studied in 8 male students in 3-hour intervals during periods of 24 hours. Two 24-hour preflight periods revealed the basic normal daily periodicity of 17-OHCS excretion. Effects of a 6-hour time shift were evaluated by determining the excretion rate after flights from Cologne/Germany to Chicago/USA and vice versa on day 1,3,5, and 8 after arrival. A desynchronization with the new local time was observed after flights in both directions, the diurnal 17-OHCS excretion patterns being more disturbed, however, after the West-East flight. The resynchronization time of maximum and minimum excretion was about 5-8 days after the westward travel and more than 8 days after traveling in the opposite direction. It is suggested that an unfavorable flight schedule, which at present is practiced by most airlines for flights from the USA to Europe, mainly accounts for the more marked time shift effects observed after the eastward flight.

243. WEITZMAN, E.D., D. GOLDMACHER, D. KRIPKE, P. MACGREGOR, J. KREAM and L. HELLMAN. 1968.
Reversal of sleep-waking cycle: Effect on sleep stage pattern and certain neuroendocrine rhythms.
Trans. Amer. Neurol. Assoc. 93:153-157.

244. WEVER, R. 1969.
Autonomous circadian rhythms in men as influenced by different light conditions.
Pflugers Arch. Eur. J. Physiol. 306(1):71-91.

Until now, the circadian rhythm, autonomous, as confirmed subsequently by the results, was tested with 75 human subjects in complete isolation from environment: 52 subjects lived under constant illumination, also while sleeping; 20 subjects switched on the light while getting up, and switched it off while going to bed (illumination by choice); with 3 subjects, the illumination was changed between the 2 kinds mentioned before. With 38 subjects, the intensity of illumination was varied during the experiment, in order to examine the influence of light intensity on the circadian period. The interpretation of all the results show that, under illumination by choice, the period is longer, the standard deviation around the mean value of period is greater, and the tendency for internal desynchronization is greater than under constant illumination. These results correspond with predictions derived from a hypothesis for circadian rhythms. Only under illumination by choice, the circadian period depends on the intensity of illumination, according to the following rule: the correlation between light intensity and period tends to be positive in individual experiments, and it is negative in group experiments; this result corresponds with theoretical considerations. Against that, under constant illumination the periods depend frequently on light intensity. In order to explain these results, the hypothesis is offered that also under objectively constant illumination, the subject is exposed subjectively to a light-dark cycle, because the eyes are open during activity time and closed during rest time. It follows that, under constant illumination, the same feed-back of the self-selected light-dark cycle on the circadian period is effective as under illumination by choice, but to a smaller amount.

245. WEVER, R. 1966.
The duration of re-entrainment of circadian rhythms after phase shifts of the Zeitgeber. A theoretical investigation.
J. Theor. Biol. 13:187-201.

A model equation of circadian rhythms describes all known general results under constant conditions and under the influence of Zeitgebers. This equation is used for computing influences of phase shifts of the Zeitgebers on circadian rhythms. A phase shift of the Zeitgeber corresponds to the shift of local time as a result of long-distance flights in eastward or westward direction. The theoretical results of 4 types of 6-hr. phase shifts and of 4 types of 12-hr. phase shifts are compared with corresponding results of animal and human experiments. The duration of re-entrainment to the shifted Zeitgeber is of especial practical interest, because the shifted subject is less efficient during re-entrainment. This duration depends, for instance, on the direction of the phase shift and on the natural period of the shifted subject. For practical purposes, rules for shortening the duration of re-entrainment are derived from the theoretical results. (Author)

246. WEVER, R. 1968.
(The effect of weak electromagnetic fields on the circadian rhythms of man.)
Einfluss schwacher elektro-magnetischer Felder auf die circadiane Periodik des Menschen.
Naturwissenschaften 55(1):29-32.

The effects of the recently discovered 10 Hz electro-magnetic field that surrounds us on the circadian rhythms of man was investigated. Two identical underground rooms were used for the experiment; one of these was completely surrounded with an iron covering to shield it from the 10 Hz field; an artificial 10 Hz field could also be produced in it. Subjects were completely unaware of the nature of the experiment and of the presence or absence of fields. Both the natural and the artificial fields were shown to have an accelerating effect on rhythm; this effect was greater, the longer the subject was previously held in a field-free environment. Secondly, both fields were found to slow down internal desynchronization. The authors conclude that it is possible to simulate the natural field with an artificial one; however, this does not mean that the 10 Hz component of the natural field is the only effective component; it only means that the 10 Hz component is important. In addition, these experiments show that the circadian rhythms can be affected by factors that have not previously been taken into account. (T.P.U.)

247. WEVER, R. 1968.
(The effect of weak terrestrial electro-magnetic radiation on the circadian periodicity of man.) Die wirkung schwacher elektro-magnetischer strahlung irdischen ursprunges auf die circadiane periodik des menschen.
In: Johann-Wolfgang-Goethe-University Extraterrest., Biophys., Biol., and Space Med., p. 259-266. Frankfurt, West Germany, Johann-Wolfgang-Goethe-Universitat.

The circadian periodicity of human subjects was tested in two insulated underground bunkers, one of which was shielded against the effects of the static magnetic field. Individuals or groups were isolated in the two bunkers for periods from 3 to 6 weeks. During the period of isolation, all activities as well as temperature, urine samples, physiological, and psychological data were monitored. A tendency toward internal desynchronization was observed and a relationship exists between activity and vegetative periodicity which appears to affect optimum performance. Recommendations are presented for the application of the findings to space travel. (Translated by K.W.) Reprinted from STAR.

248. WEVER, R. 1967.
(The influence of weak electromagnetic fields on the circadian rhythms in man.) Uber die beeinflussung der Circadianen Periodik des Menschen durch Schwache Elektromagnetische Felder.
Z. Vergl. Physiol. 56:111-128.

Examinations of human circadian rhythms in a specially designed underground bunker containing two living rooms, one of which is shielded against electric and magnetic fields. In this room, the influence of artificial weak electric ac fields varying at 10 cps is tested; such a field, simulating one on the natural fields in the Earth's atmosphere, cannot be perceived. The results of all experiments in the shielded room as compared to those in the nonshielded room indicated that natural electromagnetic fields have an effect on circadian rhythm. The mean period value, averaged over 29 experiments in the shielded room, was 25.65 hours; the corresponding value, averaged over 24 experiments in the nonshielded room, was 25.00 hours. Moreover, "internal desynchronization" was observed exclusively in the shielded room (in 9 experiments). In the nonshielded room, the periods

of activity and of vegetative functions were synchronized either in a 1:1 or in a 2:1 ratio (circa-bi-dian activity in 5 experiments). With these results it was concluded that the weak artificial 10 cps field and the natural terrestrial field have similar effects on human circadian rhythms. (P.V.T.) Reprinted from International Aerospace Abstracts, Inc.

249. WEVER, R. 1969.
(Investigations of the circadian periodicity in men, with particular consideration of the influence of weak alternating electric fields.) Untersuchungen zur circadianen periodik des menschen mit besonderer beruecksichtigung des einflusses' schwacher elektrischer wechselfelder. Bonn, Bundesministerium fuer Wissenshaftliche Forschung, Sept. 1969. 212p. Avail: CFSTI (N70-16360)

In a special underground bunker, circadian rhythms of 108 human subjects were studied under complete isolation from the environment. It is shown that these rhythms are influenced, not only by light, but especially by a 10-cps electric field in a regular manner. Apart from the periodic and other rhythm parameters, the tendency towards internal desynchronization depends on the respective environmental conditions. The significance of the results obtained are discussed with regard to a hypothesis of circadian rhythms. The practical aspects of the influence of weak electromeagnetic fields on human beings are proven. (Author)

250. WHILLANS, M.G. 1960.
Bioscience research and space problems.
J. Roy. Astron. Soc. 54(5):211-215.

A brief review of certain problems which will be encountered in manned space flights. Topics include: 1) disorientation and weightlessness, 2) radiations from the Van Allen belts and solar flares, 3) isolation, and 4) methods of providing food and oxygen. Remarks on some of the proposed solutions to these problems are included. Efforts to solve these problems have stimulated discussions and research into several basic areas such as the origin of life, the possibility of life on other planets, the relationship of biological rhythms to health and efficiency of the human organism, mechanisms of navigation in birds and other animals, and the possibilities of traveling in space in the supercooled or hibernating state.

251. WULFFTEN PALTHE, P.M. van. 1968.
Time sense in isolation.
Psychiat., Neurol., Neurochir. 71:221-241.

Investigation of the time estimation of various groups of subjects kept in maximum isolation in a caisson for about an hour or in caves for several months. Time sense is found to be a function of upper brain stem paraconsciousness. Its estimation of time span is given intuitively without reasoning and is moved by an inner certainty in the absence of nearly total external information. In "one hour" experiments of extreme isolation and solitary confinement, the estimate oscillates steadily around 60 percent of real time. In cave experiments lasting several months the situation

was less extreme, but the estimates by the alternating "cortical and brain stem consciousness" show an average of 60 percent of real time; however, the estimates of the time span after a sleep period differ considerably from those following a period of activity and with a lesser dispersion range. The terrestrial 24-hr rhythm is intrinsically present in the estimates. Estimation falls considerably short of real time; hence duration seems unexpectedly long. (F.R.L.) Reprinted from International Aerospace Abstracts, Inc., 1970.

252. ZURBRUEGG, P. and J. NOREN. 1968.
(Circadian rhythm of plasma cortisol under changed environmental conditions.) Plasmacortisol-Tagesrhythmus unter veranderten Umweltbedingungen.
Schweizerische Medizinische Wochenshrift (Basel) 98:724.

The effects of a one-time change in time-zone and repeated changes in work shift on the circadian rhythm of plasma cortisol was investigated. A one-time change in time-zone from America to Europe or vice versa produced on the one hnad, short-duration changes in rhythm, such as a frequency increase and a shift in the plane of oscillation to a higher level; on the other hand, the original work rhythm remained effective for several months as a supplemental timing device and led to a long-term change in rhythm, in competition with the new environmental factors. Similar cyclic disturbances were caused by repeated changes in work shift for the maintenance staff. In contrast to the observations during a time-zone change, these oscillations could not be brought into meaningful synchronization with the newly effective work rhythms. Such working conditions obviously lead to a far-reaching and unusually sustained desynchronization. As a result, our chosen experimental conditions produced the most severe rhythm disturbances continuously over several months. Some of these oscillation patterns reminded us of those observed in babies and infants. (T.P.U.)

EFFECTS OF VARIOUS STRESSORS ON PERFORMANCE

This search centers around reference dealing with performance decrements due to the stresses of alcohol, the common cold and drugs or chemical agents. Disturbances in human performance which effect flight safety is the main consideration. Combinations of various stressors, whether environmental, psychic or physiological, are studied in relation to perception, attention, work load and task complexity.

1. BERGSTEDT, M. 1969.
Disturbances of the balance system in man during alcohol hangover. In: B. Hannisdahl and C. W. Sem-Jacobsen, eds. Aviation and Space Medicine: Proceedings of the Seventeenth International Congress. Oslo, Universitetsforlaget. P. 268-294.

Description of the effect of alcohol on the balance system of man, especially during the hangover period, from the viewpoint of the demands of flying. It is found that alcohol causes distinct disturbances of the ocular-vestibular system in many during the hangover period even after small doses. This disturbance is an induced ocular nystagmus movement related to the position of the head relative to the gravitational field. The physiological relation of this disturbance to the vestibular (balance) system is clear. Its importance as one of the physiological alterations during hangover is stressed. (Z.W.)

2. CHILES, W.D. and A.E. JENNINGS. 1970.
Effects of alcohol on complex performance.
Human factors 12:605-612.

Nine subjects were tested on a battery of tasks involving monitoring, two-dimensional compensatory tracking, and mental arithmetic at three levels of work load. The subjects injected 2.5 ml of 100-proof vodka per kilogram of body weight two hours before testing; mean blood alcohol at the beginning of testing was approximately 100 mg%. Significant alcohol effects were found for two of the monitoring tasks and for three of the four measures of tracking. There was a significant interaction between work load and alcohol in the case of one tracking measure. (Author)

3. DAVIS, G.L. 1968.
Clinical aviation and aerospace medicine: Alcohol and military aviation fatalities.
Aerospace Medicine 39(8):869-872.

Enthanol was found in 102 (4.8%) of the 2,123 toxicologic analyses done at the AFIP, Armed Forces Institute of Pathology on tissue submitted from U.S. military aircraft-accident fatalities. In 94 of these cases putrefaction or contamination was associated with the formation of ethanol. Eight of the 102 cases (0.38% of the ethanol determinations) are considered significant because of the presence of ethanol without putrefaction or contamination and, therefore, related to ingestion. In only 2 instances could the significant ethanol be implicated as "probable" cause of the aircraft accident, and one of these involved a nonrated individual who had taken the aircraft without authorization. Four cases involved mechanical failures or environmental difficulties in which ingested alcohol may have been a contributory factor. In 2 cases the ethanol was found in individuals who do not appear to have been in control of the aircraft, and thus drinking had not contributed to the accident. (Authors)

4. FRANCK, M.C. and W. KUHLO. 1970.
Effects of alcohol on directed saccadic eye movements in man.
Arch. Psychiat. Nervenkr 213(3):238-245.

The alcohol concentration in the blood and expired air of 9 healthy persons was determined in 15 experiments after the oral administration of Vodka (0.9 alcohol/kg body weight). These determinations were made every 20 to 60 min. for 9 hr. The maximal speed of 20 saccadic eye movements (SEM) was measured electrooculographically at the same time. The speed of SEM for 20 amplitude ranged between 338°/sec. and 46° sec. in subjects without alcohol. The speed was significantly decreased in all subjects who had taken alcohol (average 23.8% of the prealcoholic value). Spontaneous slowing down in 2 persons without alcohol was only 0.9%. Greater slowing down was observed in diurnal variations. The correlation between blood-alcohol concentration and the decrease in speed was not a straight line but a parabolic curve; i.e. with relative low alcohol concentration more slowing occurred over time of alcohol concentration than with higher alcohol concentration in the course of the experiment. The maximal decrease in eye movement occurred later, approximately 1 hr after the alcohol concentration in the blood had reached its maximum.

5. FREGLY, A.R., M. BERGSTEDT, and A. GRAYBIEL. 1965.
Some relationships between blood alcohol, Positional Alcohol Nystagmus (PAN), and Postural Equilibrium (ATAXIA).
Naval School of Aviation Medicine, Pensacola, Fla. 19 p.

Quantitative relationships were explored between blood alcohol levels, positional alcohol nystagmus (PAN), and postural equilibrium performances measured with a new quantitative ataxia test battery and with a series of clinical-type ataxia tests. Moderate amounts of 80-proof vodka (1 cc per lb body wt., 55-100 mg% blood alcohol level) produced appreciable decrements in the postural equilibrium functioning at all thirteen vestibular normal subjects evaluated. Maximum decrements occurred at 60-75 minutes following alcohol intake and were fairly well correlated with the peak blood alcohol levels. But more strikingly, the ataxic responses were in very close agreement with the intensity and duration of the PAN 1 (intoxication period) responses along the time axis. No systematic relationships between the ataxia test performances and PAN phase II responses were found. Ataxic performances recovered during the PAN II period. Repetition of the experiment two days later with the same subjects under increased stimulation (100-proof vodka in the same dosage) reproduced the findings generally proportional to the increased stimulus. (Author)

6. GIBBONS, H.L., J.L. PLECHUS, E.H. CHANGLER, and J.W. ELLIS. 1966.
Alcohol-induced hypoglycemia as a factor in aircraft accidents.
Aerospace Medicine 37(9):959-961.

A case history of an aircraft accident is presented. The apparent cause of the accident was incapacitation secondary to marked hypoglycemia (blood glucose level was 20 mg% and blood alcohol level was 98 mg%). Alcohol induced hypoglycemia (AIH) is mentioned frequently in the literature. Since 30% of fatal aircraft accidents in the Federal Aviation Agency's Southwest Region have alcohol involved, an investigation was undertaken to evaluate the role of associated hypoglycemia in these accidents as a possible contributing factor. Due to the post mortem changes in blood glucose levels,

the data is considered unreliable and no conclusions were reached regarding the frequency of AIH. A phenomenon of agonal hypoglycemia is suggested, and the role of AIH in diabetes is mentioned. (Authors)

7. GIBBS, C.B. 1966.
The effect of minor alcohol stress on tracking skill.
In: NASA, Washington Manual Control p. 259.

Twenty men were tested in step-input tracking, with minor stress imposed by moderate alcohol dosage and an incompatible directional relation between control and display. Directional errors, response latencies, and eye movements were recorded before and after drinking, when breathalyzer readings were zero, and at 0.05 and 0.1% breathalyzer levels which may be produced in a man weighing 160 pounds by drinking two and four 12-ounce bottles of beer, respectively. Alcohol caused a progressive increase in response latencies in and errors (p. 0.01): there was no evidence for a threshold below which alcohol has no adverse effect. The test emphasized the markedly different effects of the same alcohol dosage on the skill of different subjects, but habitual drinkers obtained no undue advantage on the test. The effects of a dose producing a 0.05% breathalyzer reading were not significantly different in an ascending or descending series of levels of intoxication. The alcohol dosages tested had no significant effect on simple reaction time. (Author)

8. GREGOIRE, H.G.R.S. KENNEDY, W.F. MORONEY, R.M. BALE, and D.G. SMITH. 1970.
Comparative motion sickness symptomatology and performance decrements occasioned by hurricane penetrations in C-121, C-130, and P-38 Navy aircraft.
In: Aerospace Medical Association, Annual Scientific Meeting, 41st. Preprints of Scientific Program, Washington, D.C., Aerospace Medical Association, p. 150, 151.

9. HAMILTON, P. and A. COPEMAN. 1970.
The effect of alcohol and noise on components of a tracking and monitoring task.
Brit. J. Psychol. 61(2):149-156.
Recent findings in stress research indicate the necessity for examining the distribution of the operator's attention in complex tasks as well as his information transmission capabilities. This study examines the effects of alcohol and noise on a complex tracking and signal-detection task with particular reference to changes in selective attention. The operator was instructed to give the tracking task priority. In noise tracking performance improved, but detection of lights placed on the periphery of vision was degraded. Alcohol had the same effect on peripheral detection, but tracking performance fell. The effect of alcohol on such simulated driving skills embodied 2 factors: the 1st an increase in attentional bias towards the high priority regions of the visual field, and the 2nd a decrease in the information transmission rate. Since from the point of view of the tracking task these factors are mutually antagonistic, there may be an offsetting of the loss in transmission rate by more optimal dispositions of attention. The loss of peripheral awareness in this event is inevitable, and even at the low alcohol levels used was of apparently serious proportions.

10. HARPER, C.R. and W.R. ALBERS. 1964.
Alcohol and general aviation accidents.
Aerospace Medicine 35:462-464.

Study of 158 general aviation fatal accidents in which routine toxicological examinations were performed on the pilots. This represents one-third of the total number of general aviation fatal accidents for the year 1963. It was found that 56 of the 158 cases were positive for blood and/or tissue alcohol, representing 35.4% of the total general aviation fatal accidents studied. All classes of airmen and all pilot ratings were found in the positive alcohol group. The incidence of student pilot involvement in this group was found to be almost twice that in the overall fatal accident population. An interesting finding was that almost one-half of the alcohol-positive group crashed within eighteen minutes or less of takeoff. An analysis of total pilot flight time in the positive alcohol group reveals a high incidence of fatal accidents in the low total pilot time range around 300 hours. The positive alcohol group was found to have a night accident rate twice that of the overall fatal accident group. A much higher incidence of proven alcohol in pilots in fatal general aviation accidents than was previously known is observed. The study is considered to add support to Aksnes' finding that relatively low levels of alcohol adversely affect flying performance. The results are said to show the need for further medical and human factors studies in civil aircraft accident investigations.

11. HIGGINS, E.A., J.A. VAUGHAN, and G.E. FUNKHOUSER. 1970.
Blood alcohol concentrations as affected by combinations of alcoholic beverage dosages and altitudes.
Aerosp. Med. 41(10):1129-1132.

This study established blood alcohol levels in man at 12,000 ft with and without supplemental 0_2 and at 20,000 ft with supplemental 0_2. At 2.50 ml of 100 proof bourbon kg body weight, subjects exhibited a lower blood alcohol level at 12,000 ft without supplemental 0_2. A difference in blood alcohol levels was not seen with 1.25 ml of 100 proof bourbon kg body weight. Dehydration effects alone could not account for these findings. The effect of breathing a normal 0_2 mixture could not be ascertained with the data collected. An increased mobility of the gastrointestinal tract caused by the high alcohol concentration and the increased mobility attributable to the lowered barometric pressure could increase the absorption rate of the alcohol at 20,000 ft with the high dose, thereby contributing to higher blood alcohol levels.

12. HIGGINS, E.A., A.W. DAVIS,JR., J.A. VAUGHAN, G.E. FUNKHOUSER and E.M. GALLERSTON. 1968.
The effects of alcohol at three simulated aircraft cabin conditions.
Federal Aviation Administration, Oklahoma City, Okla., Office of Aviation Medicine. 17 p.

In a study of 54 human subjects using three alcohol consumption levels and three simulated cabin conditions it was found that alcohol caused an increase in heart rate and an increase in skin temperature. Internal body temperature was lower with alcohol but did increase as blood alcohol levels decreased. The performance tests used apparently were not critical enough to detect differences due to single influences.

Blood alcohol determinations for subjects receiving the high level of alcohol yielded significantly higher levels of blood alcohol for subjects at 200,000 ft. than at the other altitudes. However, the readings at 20,000 ft. were not significantly different than readings obtained at the other altitudes for subjects receiving the lower dose of alcohol. (Author)

13. KLEIN, K.E., K.L. BREUKER, H. BRUNNER, and H.M. WEGMANN. 1967.
Blood alcohol and air unfitness. Test to evaluate regulations for general aviation.
Int. Z. Angew. Physiol. Arbeitsphysiol. 24(3):264-267.

Alcohol was ingested in 3 different doses (0.28, 0.56, 0.84 g/kg body weight within 10-15 min) by young healthy males, and the blood alcohol concentration (BAK) and the psychomotor performance were measured in regular intervals of 20-60 min for more than 5 hr. The ability to perform a complex psychomotor performance test as quickly and as accurately as possible, was significantly reduced in the group (and in each individual), if the BAK reached 0.015% (-0.025%) in the phase of the alcohol resorption, if the BAK was 0.035% (-0.045%) in the plateau, or if it was as high as 0.045% (-0.050%) in the phase of the alcohol elimination. The reduction in performance at a BAK plateau of about 0.09% corresponded well to the reduction caused in the same group by 0.5 g Hexobarbital (Evipan) taken orally. The results emphasize the necessity of a regulation related to drinking, which, as in airline and military crews usual, prohibits a person from acting as a crew member in general aviation for a given time after the consumption of alcoholic beverages. (Authors)

14. MAC GILLIVRAY, B., R.T. KADO, and W.R. ADEY. 1966.
Effects of alcohol on brain-tissue impedance in animals and man.
California Univ., Los Angeles, Brain Research Inst. 14 p.

The effect of blood alcohol levels to 240 mg./100 ml. on the impedance of the amygdala, hippocampus, lateral geniculate bodies (normal and degenerated, 1 year after striatal cortex ablation), and the midbrain reticular formation, has been examined in cats. The characteristic response to alcohol was a fall in both the reactive and resistive components of impedance. No regional differences were found. There was no significant change in impedance in the degenerated lateral geniculate bodies. The pes hippocampus of 2 human subjects showed the same response to alcohol as the normal cat brain. (Author)

15. MARAMAN, G.V. 1970.
The effects of alcohol on three levels of complex human behavior.
National Aeronautics and Space Administration, Langley Research Center, Langley Station, Virginia.

Each level of complexity contained an increasing component indicative of cognitive behavior. The motor component of all three levels was maintained approximately constant. The blood alcohol concentrations studied were 0.000, 0.010, 0.050, and 0.100 percent, as determined with the Breathalyzer. Alcohol was administered in the form of 50 percent

ethanol mixed with frozen orange juice concentrate. All blood alcohol concentrations were studied in the same subject during one test session. The study was replicated. The study was repeated twice without alcohol. Data are presented which indicate that cognitive processes were not affected by these blood alcohol concentrations. Performance on all three tasks was affected significantly, however, the effect of the alcohol appeared to be on the subject's ability to make precision positioning movements of the limbs. (Author)

16. MOHLER, S.R., W.H. BERNER and L.R. GOLDBAUM. 1968.
Alcohol question in aircraft accident investigation.
Aerosp. Med. 39(11):1228-1230.

The purpose of determinations of blood or tissue alcohol in the pilot victim of an aircraft accident is to assist the National Transportation Safety Board in assessing the role played by alcohol relative to causing or contributing to the accident. Also, the extent to which alcohol is involved in aircraft accidents decides how extensive the Federal Aviation Administration's education and other safety programs are conducted. A progressive increase in toxicological examinations of fatal general aviation accidents has occurred, from 29% in 1963 to 74% in 1967. In 1967, 23% of the accidents investigated toxicologically presented blood alcohols in excess of 150 mg%, obviously indicating that continued airman education and other preventive programs are desirable. To minimize laboratory errors, it is recommended that samples from a given accident be split between 2 laboratories, at least 1 being experienced in forensic pathology (for example, the Armed Forces Institute of Pathology).

17. MOHLER, S.R. 1966.
Recent findings on the impairment of airmanship by alcohol.
Federal Aviation Agency, Washington, D.C. Office of Aviation Medicine.

A significant number of fatal general aviation accidents have definitely been associated with the effects of consumed alcohol. These effects can markedly impair the judgment and proficiency of airmen. Aspects of this subject are explored in depth. (Author)

18. MULLER, B.P., R.D. TARPEDY, A.P. GIORGI, L. MIRONE and F.L. ROUKE. 1964.
Effects of alcohol and mephenoxalone on psychophysiological test performance.
Dis. Nerv. Syst. 25(6):373-375.

19. RYBACK, R.S. 1970.
Aeromedical consultation service case report: two forms of alcohol amnesia.
Aerospace Med. 41:930-931.

20. RYBACK. R.S.
Effects of alcohol on memory and its implications for flying safety.
Aerospace Medicine 41(10):1193-1195.

Alcohol most severely disrupts short-term memory in man. This is briefly presented in terms of social drinking, state-dependent learning, alcohol amnesia, the Wernicke-Korsakoff syndrome and pathological alcoholic intoxication. The implications of the latter are discussed in terms of flying safety. (Author)

21. SCHROEDER, D.J. 1970.
The influence of two levels of alcohol on vertigo and on nystagmic responses to angular acceleration.
In: Aerospace Medical Association, Annual Scientific Meeting, 41st. Preprints of Scientific Program, Washington, D. C., Aerospace Medical Association, p. 122.

22. SMITH, R.C. 1970.
Effects of alcohol on problem-solving performance.
In: Aerospace Medical Association, Annual Scientific Meeting, 41st. Preprints of Scientific Program, Washington, D.C., Aerospace Medical Association, p. 118, 119.

23. SUTTON, D. and J. KIMM. 1970.
Alcohol effects on human motor unit reaction time.
Physiol. Behav. 5(8):889-892.

Control of single motor unit activity in adult human subjects (59-73 kg) was studied by requiring a single spike discharge to a flash of light and recording the resultant reaction time (RT), Experimental sessions without alcohol were followed by ingestion of 20 cm^3 95% ethyl alcohol and re-testing the reaction time performance. Median latencies were slower following the intake of alcohol; however, the capacity to respond as defined simply by the ability to produce a motor unit spike was not altered. Electromyographic RT responding also slowed following alcohol, although to a lesser degree than did single motor unit RT.

24. TALLAND, G.A. 1966.
Effects of alcohol on performance in continuous attention tasks.
In: Alcoholism: A symposium on recent advances in biological and behavioral research. Psychosom.Med. 28(4 Pt. 2):596-604.

Alcohol addicts and control subjects were tested by experimental tasks to determine the effect of moderate doses of whiskey on performance demanding continuous attention over relatively long periods. When working in isolation the 2 groups of subjects did not differ significantly in accuracy, nor did alcohol significantly affect their performance. Working under competitive instructions in a group setting, the addicts made more errors than the control subjects, and alcohol impaired accuracy in both types of subject. Questionnaire data revealed considerable uncertainty about the alcohol content of the beverages, little reliance on their taste, and a predominantly unfavorable evaluation of alcohol effects. An experiment in signal detection requiring rapid search showed a sizable drop in performance as a result of alcohol, and gradual improvement as the toxic effects wore off. (Author)

25. TANG, P.C. and R. ROSENSTEIN. 1967.
Influence of alcohol and Dramamine, alone and in combination, on psyshomotor performance.
Aerosp. Med. 38(8):818-821.

The effect of alcohol and Dramamine, alone and in combination, on the performance of 4 young adult subjects on the Scow Complex Coordinator was studied in a series of 8 experiments. Alcohol alone produced a 12.5% decrease in performance when the blood alcohol level was between 44 mg% and 50 mg%. When the blood alcohol decreased to 35 mg% level, the performance decrement became insignificant. Dramamine alone in dosage

of 100 mg/person produced relatively insignificant performance decreases (maximum 6%). The combination of alcohol with Dramamine produced much larger performance decrements. During the 1st 3 hours following ingestion of Dramamine and alcohol, the performance decrements were 8%, 25%, and 9%, respectively, when the blood alcohol levels were 50 mg%, 44 mg%, and 34 mg%. Reasons for not recommending a maximum permissible alcohol level for airmen are discussed. (Authors)

26. TARTER, R.E. 1970.
Dissociate effects of ethyl alcohol.
Psychonomic. Sci. Sect. Hum. Exp. Psychol. 20(6):342-343.

Alcohol was demonstrated to have dissociative properties in a negative transfer task but not in a relearning task. In addition, alcohol retarded the rate of acquisition of new learning in humans.

27. VAN LAER, E.K., M.E. JARVIK, and J. VAN LAER. 1965.
Effects of ethyl alcohol on retention in a delayed-response test.
Quart. J. Stud. Alcohol 26(3):384-392.

The purpose of this experiment was to determine the sensitivity of delayed response performance to ethyl alcohol, especially whether the impairment of performance would be due to decreased retention of information over delay periods or to a reduction of the capacity or motivation to perform the required response. The Ss were 6 Rhesus monkeys, weighing 5 to 8 kg. They had received extensive training on the delayed response test prior to initiation of the present experiment. The monkeys were water-deprived for 24 hours, and drank between 75 and 450 cc (median 350 cc) of a 6% (v/v) solution of ethyl alcohol. They were required to touch a panel upon the appearance of a dim light only if it was preceded by a bright light. Two lengths of delay intervened between the preparatory (bright) and releasing (dim) lights. In each block of 40 trials there were 10 trials with a 1-sec delay and 10 trials with an 8-sec delay between termination of the bright light and onset of the dim light. These were interspersed randomly with 20 catch trials on which the dim light was not preceded by the bright light. The intertrial interval was 20 sec. If the subject failed to respond to the dim light when it had been preceded by the bright light, this was an error of omission. An error of commission occurred whenever the subjects responded to the dim light on catch trials. The over-all effect of alcohol was to increase errors of both types significantly. More errors of omission were made on long than on short delay trials, under both alcohol and control conditions. However, there was no interaction between drug and delay. The increase in omission errors for long delay trials was nearly identical to that observed on short delay trials. In the control condition, errors of omission and errors of commission occurred with approximately equal frequency. Alcohol increased errors of ommission to a significantly greater extent than errors of commission. The absence of an interaction between drug and delay led to the conclusion that the error-producing effect of ethyl alcohol was not due to impaired retention over the delay periods. Since alcohol increased rather than decreased errors of commission, it cannot be concluded that alcohol impairs the ability to perform the response. It was hypothesized that the primary effect of alcohol was to interfere with processes of perception and attention. (Authors)

28. WICK, R.L., C.E. BILLINGS, and L.P. LEONELLI. 1970.
Studies of pilot performance - Effects during flight of graded doses of alcohol on professional pilots.
In: Aerospace Medical Association, Annual Scientific Meeting, 41st. Preprints of Scientific Program, Washington, D. C., Aerospace Medical Association, p. 120, 121.

29. WILKINSON, R.T. and W.P. COLOQUHOUN. 1968.
Interaction of Alcohol with incentive and with sleep deprivation.
In: Journal of Experimental Psychology 76:623-629.

Twenty-eight enlisted men carried out a 30-min. choice serial reaction test four times under all possible combinations of alcohol (A) (70 cc. of 90.5% proof spirit 45 min. before testing) and placebo (P) (a similar non-alcoholic drink) with 30-hr. sleep deprivation (SD) and normal sleep (NS). In accuracy the adverse effect of A was reduced by SD. In speed scores it was reduced in low blood-alcohol subjects but increased in high ones. In Experiment II knowledge (KR) and no knowledge (NKR) of results replaced the variables of SD and NS. KT increased the adverse effect of A upon speed and marginally, upon accuracy. Behaviorally a moderate dose of alcohol appears to act as an arouser not a depressant, except, in susceptible subjects who have lost sleep. (Authors)

COMMON COLD

30. BECK, R. H. 1964.
Jet crew fatigue. II.
Air Line Pilot, 33:3-7, 21-23.

Discussion of factors affecting jet crew efficiency. Visual difficulties inducing fatigue arise from various causes associated with altitude and hypoxia. Excessive smoking has the effect of raising the apparent altitude at which the crew member is working. Jet flight may contribute to atherosclerosis and heart disorders to an extent not definitely proven as yet. Colds impair judgment and reduce physical performance with possible permanent ear damage. Noise and vibration contribute to fatigue. The toxic effect of ozone is not a serious factor at present, but will pose an exposure problem at altitudes at which future supersonic transports will fly. Other factors affecting jet crew fatigue are extremes of temperature and humidity, workloads and increased responsibility, intensified inspections of pilot personnel, personal problems, and apprehension. Fatigue produces a willingness to accept lower standards of accuracy and performance, which may create conditions of reduced safety.

31. FUNK, J.W. 1963
The common cold - a continuing aeromedical problem.
Aerospace Medicine, 34:1058-1061.

Brief discussion of problems associated with the common cold, its incidence in pilots, and its importance as a cause of their loss of effectiveness. The clinical syndrome is described, and the underlying pathophysiologic mechanism is postulated. Treatment is discussed, along with some aeromedical therapeutic management technique.

32. LUNDGREN, E.G. and L.U. MAIM 1966.
Alternobaric vertigo among pilots.
Aerospace Medicine. 37:178-180.

The occurence of alternobaric vertigo - vertigo due to pressure changes in the middle cars - was studied by means of interviews of 108 Swedish RAF pilots. The findings are presented as statistically analyzed data and case reports. The incidence of vertigo was higher than in an earlier investigation. A positive correlation was found between colds, mismanagement of colds, difficulties in pressure equalization of the middle ears and the occurence of vertigo. Information is given which stresses the risks connected with alternobaric vertigo in flying.

33. BAETTIG, K. and H. FISCHER. 1966.
Do non-prescription analgesics and placebos have a varied effect on subjective feelings, personality and psychomotor performance.
Schweizerische Medizinische Wochenschrift. 96(17):570-575.

In a group of 29 students, 3 tablets of Saridon and 3 tablets of placebo alike failed to have any significant effect on performance in 6 different psychomotor tests or on the results of a quantitatively measurable personality test. In another quantitative test of subjective feelings, the placebo produced significant changes in mood (sedation and euphoria). The effect of Saridon was weaker than that of the placebo, although a similar tendency was noticeable. In none of the cases was the difference between the two treatments significant.

34. BARRINGTON, J.D., et al. 1967.
Reduced pressure potentiation of the side effects of the antimalarial, Dapsone.
Aerospace Medicine. 38:1151-1154.

Examination of ways of protecting aircrews operating in Southeast Asia from drug-refractory strains of falciparum malaria. Since side effects such as anemia and methemoglovinemia are seen as a result of Dapsone therapy, this investigation was undertaken to determine if the stress of altitude would potentiate these harmful effects. Four groups of male Sprague-Dawley rats (250 to 350 gm) received one week of pretreatment (intraperitoneal injection) with diaminodiphenyl-sulfone (Dapsone, USP) at dose levels of 0.5, 1.0, 2.5, and 5.0 mg/kg, respectively. Each of the four groups were divided into two subgroups. Treatment with Dapsone continued throughout the second week with daily injections to subgroup I at ground level and subgroup II at a simulated altitude of 18,000 ft. and ground level equivalent PO_2 (42% C_2) for 4 hr daily. Blood was drawn from each subgroup and their corresponding untreated controls by cardiac puncture on the first, third, and fifth day of the second week of treatment. The results of this study show that hypobaric conditions, with ground equivalent oxygen, increase the relative toxicity of Dapsone on rats when compared with animals treated at ground level. This increase in toxicity is evidenced by marked decreases in reticulocyte count ($P<.01$), hemoglobin values ($P<.01$), and erthrocyte count ($P<.01$) at the 0.5-mg/kg, 1.0-mg/kg, and 5.0-mg/kg dose levels after 4, 12, and 20 hr respectively, of simulated flight at 18,000 ft on 42% oxygen. A "Pressure Factor," separate from the hypoxic factor, heretofore disregarded or unrecognized on the pharmacological action of drugs in hypobaric or hyperbaric drug studies, is proposed as the precipitating cause for the observations seen. The implications of this concept on aerospace medicine are discussed. (Author)

35. BARRY, H. and J.P. BUCKLEY. 1966.
Drug effects on animal performance and the stress syndrome.
J. Pharm. Sci. 55(11):1159-1183.

36. BELAY, V. Ye., et al. 1970.
Effect of some drugs on animal tolerance to extreme stress.
Space Biol. Med., USSR. 4(1):28.

A comparative study of neurotrophic drugs effecting acute hypoxic hypoxia, prolonged transverse accelerations, and maximum physical loads is reviewed. The dosage and pharmacological properties of the drug affecting animal tolerances are analyzed. Experimental results are summarized, including tests on psychosedative drugs and tranquilizers.(J.A.M.)

37. BLUM, B., et al. 1964.
A comparative evaluation of the action of depressant and stimulant drugs on human performance.
Psychopharmacologia. 6(3):173-177.

The effects of orally administered alcohol (10 and 20 cc), alcohol (10cc) together with distractions, of pentobarbital (150 mg), of amphetamine (7.5 mg) and of caffeine (100 and 200 mg) on performance of motor and intellectual tasks by intelligent human subjects was studied. Pentobarbital depressed all of these tests, whereas the other drugs showed differential actions: alcohol prominently increased errors in the addition test at doses not affect- other intellectual tasks or motor performance. Amphetamine and caffeine decreased errors on mental tasks while not affecting the motor tasks. Distraction acted in these individuals as a stimulant, decreasing errors apparently by raising the level of alertness, and it also counteracted the deleterious effects of alcohol on these tasks. (Authors)

38. BROWNING, W.H. 1970.
Deleterious effects of cigarette smoking and 100% oxygen on aircrew members in high performance aircraft.
Aerospace Medicine. 41:39-42.

Results of comparative vital capacity measurements made preflight and postflight on jet fighter aircrew breathing 100% oxygen during one hour missions involving brief periods of practice air combat maneuvering at G forces from +0.5 to +6.5. During high G profiles, there was 7% average loss of vital capacity in flight, with a range from 0 to 37%. Half of the subjects had not recovered the lost volume 30 minutes after landing. Smokers had an in-flight volume loss that was 3 1/2 times that noted among nonsmokers under high G conditions. Nonsmokers had no in-flight loss under low G conditions. Control runs on 20% oxygen-80% air showed no in-flight volume loss. It was concluded that 100% oxygen has a deleterious effect on aircrew members in the air combat environment. This effect is grossly aggrevated among cigarette smokers. (Author)

39. CHILES, W.D., et al. 1969.
Effects of two common medications on complex performance.
Federal Aviation Administration, FAA-AM-69-9, Oklahoma City, Okla. 5 pages.

The performance of 10 subjects was measured over 4-hour periods following the administration of normal clinical dosages of Donnatal (two sessions). Chlorpheniramine maleate (one session) and a placebo (one session) in a double blind experiment. Prior to the experiment, the subjects were given extensive training on the battery of tasks used. The subjects were tested as two 5-man crews on the tasks which were designed to assess psychological functions of the kind involved in aircraft operations: included were measures of monitoring information processing, visual discrimination and "crew coordination." Although performance was in general "numerically" inferior under the chlorpheniramine maleate condition, no effects were found that could be statistically attributed to the drugs administered. (Author)

40. COLER, C.R., et al. 1965.
Effects of adrenalin or insulin on the performance of working and resting subjects.
National Aeronautics and Space Administration, NASA-TM-X-56371, Washington, D. C. 22 pages.

The performance and physiological effects of adrenalin or insulin were studied in human subjects. After approximately eight hours of enforced work or rest, one group of nine subjects received insulin, and another group of nine subjects received adrenalin. The subjects in each drug group participated in both a working condition and a resting condition on separate occasions. Short-term memory, choice reaction time and steadiness tests were used to evaluate subject performance. Ten preinjection and seven post-injection sessions of performance testing were given. Postinjection performance decrements occurred on all three tests for all subjects, both working and resting, in the insulin group. Fewer decrements occurred in the adrenalin group. For the insulin group, postinjection decrements were most frequent in the working condition. However, for the adrenalin group, postinjection decrements were most frequent in the resting condition. Performance in the working condition of the insulin group had not recovered to preinjection levels three hours after injection, while recovery had occurred in all other conditions. (Author)

41. COOPER, K.H., et al. 1963.
Effects of cigarette smoking on endurance performance.
J. Amer. Med. Ass. 203(3):189-192.

By means of a 12-min field test, the effect of cigarette smoking on endurance performance was measured in 419 airmen before and after 6 weeks of basic training. In 47 airmen, cardiopulmonary indexes also were obtained during maximal treadmill performance. Field testing showed that endurance performance was inversely related to the number of cigarettes smoked daily and the duration of smoking. The training response also was impaired significantly in the smokers. During treadmill studies, smokers had a decrease

in respiratory minute volume and a lower O_2 consumption at equivalent heart rates than nonsmokers. Further statistical studies demonstrated not only the independent effect of smoking, but also the effect of prior athletic history and physical characteristics on endurace performance. The latter effects become less significant as physical training progressed.

42. DILLE, J.R. 1969.
Drug and toxic hazards in general aviation.
Aerospace Medicine. 40:191-195.

Discussion of both the potential and the documented roles of drugs, alcohol, pesticides, and carbon monoxide in general aviation accidents. The drugs discussed include analgesics, antihistamines, nasal decongestants, motion sickness medications, amphetamines, tranquilizers and sedatives, cardiac agents, muscle relaxants, steroids, drugs for hyperuricemia, anticholinergics, and " the pill." With regard to alcohol, further research is indicated to better identify the legal level of intoxication with flying. (G.R.)

43. FIGAROLA, T.R. and C.E. BILLINGS. 1966.
Clinical aviation and aerospace medicine: Effects of meprobamate and hypoxia on psychomotor performance.
Aerospace Medicine. 37(9):951-954.

This study was designed to assess the effects of meprobamate, alone and combined with hypoxia, on the ability of normal human subjects to perform several complex psychomotor tasks simultaneously. Six male subjects were required to perform a bidimensional tracking task, to solve coded problems and to respond to infrequent changes in the intensity of an auditory signal. The tasks were performed for 36 min. on 6 occasions while subjects were taking either meprobamate, 400 mgm 3 times daily, or a matched placebo. While taking drug or placebo, subjects were exposed in an altitude chamber to either 3,000, 8,000 or 17,000 ft. pressure altitude on 3 separate days. Performance was assessed under each of the 6 possible combinations of drug(or placebo) and altitude. The results indicate that meprobamate in this dosage exerts a decremental effect on certain elements of complex task performance. This effect is approximately additive to the decremental effect of hypoxia. The effect of meprobamate was obvious only during periods when subjects were relatively heavily loaded; it was not significant during periods when subjects were performing the tracking task alone. (Authors)

44. FINE, B.J. 1968.
Personality traits as related to symptomatology and running performance at altitude under normal and drug (acetazoleamide) conditions.
Perceptual and Motor Skills. 27:975-990.

An individual-differences approach was brought to bear on data obtained from a large, multi-disciplinary field study of the effects of altitude on a number of variables, including running performance and illness symptomatology. Personality-related effects of altitude on both performance and symptoms were obtained under placebo and drug (Acetazoleamide) conditions. In addition, age and cigarette smoking were found to be positively related to decrements in running performance from sea level to altitude. The findings supplement certain of the conclusions and generalizations produced by a groups-oriented approach in that the results suggest that Acetazoleamide (1) may adversely affect running performance in some types of individuals, (2) does not appear to reduce illness in some types of individuals, and (3) that Ss for whom the drug appears to be effective in reducing the symptoms of illness appear to be among those in whom the drug induces a performance decrement. (Author)

45. GANSLEN, R.V., et al. 1964.
Effects of some tranquilizing, analeptic and vasodilating drugs on physical work capacity and orthostatic tolerance.
Aerospace Medicine. 35:630-633.

Study of the drugs Caffeine-Metrazol, Recordil, and Equanil. The following observations are made. Caffeine-Metrazol: a combination of this drug appears to have potency as antifatiguing medication and ergogenic aid, accomplishing an improvement in cardiac economy by increasing the stroke volume at a lowered heart rate and augmenting maximum cardiac output as well as maximum oxygen intake. Recordil (Flavon-7-ethyl-oxyacetate): the physical working capacity of the subjects is materially benefited by this drug, taken four hours before the exercise test. The absence of localized fatigue and leg pain supports the thesis that peripheral vasodilation is present and effective. The psychic-excitatory effect of Recordil cannot be explained except on the basis of some conceivable increased cerebral blood flow mechanism for which there is no evidence at this time. Equanil: disturbances of the vasomotor system become evident. A real hazard seems to exist with the tendency of blood pressures to be depressed, particularly with subjects who naturally possess low blood pressure. These vasomotor disturbances suggest central-nervous system depression, especially of thalamic origin.

46. GELFAND, S., et al. 1968.
Magnesium pemoline: Stimulant effects on performance of fatigued subjects.
Clin. Pharmacol. Ther. 9(1):56-60.

Magnesium pemoline, 100 mg, as compared to placebo, facilitated performance of fatigued subjects required to do repetitious arithmetic problems for 5 hr. It acted like methylphenidate HCl, 20mg, and d-amphetamine, 15 mg, by maintaining speed and accuracy near a predrug base line. Snaller doses of magnesium pemoline, 25 and 50 mg, were not significantly different from placebo. (Auth.)

47. GURIN, I.S., et al. 1968.
Medicinal therapy and flight safety.
Kosmicheskie Issledovaniia. 6:782-787.

Analysis of the side effects of drugs and their significance for the future activity of pilots and astronauts. The data discussed are mostly from American sources. It is noted that in the U.S. in order to make rational use of drugs the following measures have been adopted: (1) a handbook on the safe uses of drugs in aviation medicine has been released; (2) lists of drugs permitted for use by flight personnel have been established; (3) instructions on the dangers of self-treatment have been developed; (4) mandatory verification of the tolerance of astronauts to the drugs included in their onboard medicine chests has been authorized; and (5) pharmacological groups of preparations which should be tested under conditions where space flight factors act on the organism have been outlined. Aerospace medical workers are urged to conduct corresponding experiments on the questions raised. (I.P.)

48. HARTMAN, B.O. and R.E. McKENZIE. 1966.
Hangover effect of secobarbital on simulated pilotage performance.
Aerospace Medicine. 37(11):1121-1124.

The results on 64 subjects performing a simulated flying task for 4 hours under one of 4 treatment conditions (3.0 gr. of secobarbital, 1.5 gr. of secobarbital, placebo, or control) indicated that 3.0 gr. of secobarbital administered the previous evening 10 hours prior to the"flight" produced degraded performance with associated subjective reports of a "hangover" effect. No degredation of performance was obtained with a dose level of 1.5 gr. (Author)

49. HIGGINS, E.A., et al. 1968.
Effects of two antihistamine-containing compounds upon performance at three altitudes.
Federal Aviation Administration, FAA-AM-68-15, Oklahoma City, Okla. 12 pages.

In a study of 45 human subjects it was determined that a compound drug containing the antihistamine phenindamine did not statistically impair performance on a modified Mashburn coordinator. Another compound containing the antihistamine chlorpheniramine did impair performance. Performance was also impaired by increasing altitudes. The combined effects of the chlorpheniramine compound and increased altitude proved more detrimental to performance than the sum of the decrements that each influence caused when encountered separately. Although no significant performance decrement resulted from the administration of the phenindamine compound, undesirable side-effects were noted. (Author)

50. HURST, P.M., and M.F. WEIDNER. 1966.
Drug effects upon cognitive performance under stress.
Office of Naval Research, ONR-H-66-3, Washington, D.C. 165 pages.

Three experiments were conducted to test an hypothesis concerning drug enhancement of performance under task-induced stress. Cognitive abilities subjected to examination were highly paced short-term memory and simple arithmetic skill. Changes in mood state, judgment of performance and perception of time passage completed the behavioral characteristics assessed. (Author - TAB)

51. HURST, P.M., et al. 1970.
Drug effects upon data processing as functions of storage and retrieval parameters.
Ergonomics. 13(4):435-444.

A series of experiments was performed to investigate the effects of various stimulant and depressant drugs upon performance under task induced stress. The first four experiments, each of which included d-amphetamine in one or more dosage, are summarized. This compound was generally the most facilitative of all the drugs tested, but in the fourth experiment reversed its enhancement effect. The fifth experiment, presented in detail, was performed to isolate the crucial task parameters which determine whether d-amphetamine enhances performance or impairs it. To assess further the relationship between mood and performance effects, sodium amylobarbitone was also given, either alone or in combination with d-amphetamine. Results indicated that the enhancement reversal under amphetamine was specific to high input rates, rather than a function of difficulty per se or of other alternative mechanisms. Amylobarbitone given separately was closely comparable to placebo. When combined with d-amphetamine, it yielded results not significantly different from those of d-amphetamine given by itself, both with performance and with mood ratings. The latter were at variance with published results, and precluded one additional test of the relationship between mood effects and performance under stress. (Author)

52. HURST, P.M., et al. 1967.
Drug effects upon a performance as a function of data input rate.
Office of Naval Research, ONR-H-67-1, Washington, D.C. 18 pages.

A fourth experiment was conducted as part of a series designed to test an hypothesis concerning drug enhancement of performance under task-induced stress. The drug conditions included chlordiazepoxide (25 mg), d-amphetamine (11-17 mg), placebo and no drug. Other independent variables were latency and input pacing rate. Chlordiazepoxide had a slight tendency to impair performance at both levels of pacing. D-amphetamine confirmed the previously-observed trend to enhance performance at moderate levels of pacing, but significantly impaired it at the extremely high level. Implications are derived for the role of drug effects in filtering strategies. (Author - TAB)

53. HURST, P.M., et al. 1969.
Rebound from d-amphetamine.
Office of Naval Research, ONR-H-69-1, Washington, D.C. 33 pages.

Forty-three university students, recruited as paid volunteers, served as their own placebo controls in an experiment test of immediate and delayed effects of d-amphetamine sulfate in separate doses of 10 mg. and 15 mg. The question to be answered was whether short-term performance enhancement, obtainable in some tasks with amphetamines, is paid for by a subsequent impairment of performance below the pre-drug baseline: a rebound effect that may occur independently of intervening experience, sleep deprivation, etc. Immediate and delayed ("rebound") effects were assessed with three tasks in addition to a mood slef-check list. The tasks included letter-checking, a coding test, and a test of verbal production. Neither the coding nor the letter-checking provided a check of the hypothesis. Coding showed no significant effects during either the immediate tests (1.5 to 3 hrs. after ingestion) nor during the delayed tests (19.5-21 hours and 24-25.5 hours after ingestion). Letter-checking showed a significant enhancement in the test of immediate effects, but the enhancement margin was so small that the subsequent absence of "rebound" was inconclusive. Both verbal production and mood effects, however,s showed strongly positive effects on the immediate tests, with no indication of subsequent "rebound." This finding suggests that acute medication can yield temporary enhancement without subsequent impairment beyond a return to the pre-drug baseline. This conclusion is, of course, restricted to the use of single dosages in situations where intervening activity and sleep deprivation are controlled. (Author)

54. KRONENBERG, R.S. and S.M. CAIN. 1967.
The effects of acetazolamide on physiologic and subjective responses of men to 24 hours at 14,000 feet.
Aerospace Medical Association, 1967 Annual Scientific Meeting, Washington, D.C., April 10-13, 1967, Preprints. Washington D.C., American Medical Association, p. 81-82.

Exploration of the usefulness of acetazolamide in aiding accommodation to altitude and to examine the mechanism of its action through a study of blood and cerebrospinal fluid (CSF) acid-base balance. A total of 44 experimental subjects were placed in a low-pressure chamber at either 3,000 ft. (681 torr) or 14,000 ft. (447 torr). Each subject consumed either 500 mg of acetazolamide or a lactose placebo in the form of two 250 mg gelating capsules 12 hr prior to entering the chamber. It is found that acetazolamide significantly lowered both blood and CSF HCO_3 under all conditions. (P.v.T.)

55. LASS, M. 1969.
The psychomotor performance after application of analgetics and anaesthetics in therapeutic doses under the aspect of traffic medicine.
Deutsche Versuchsanstalt fur Luft-und Raumfahrt, DVL-829, Munich, West Germany. 47 pages.

Magnitude and duration of the psychomotor performance decrement caused by some analgetic, anesthetic, and narcotic drugs (applied orally, gaseous or by injection) were measured in 12 young healthy

persons and compared with the effect of ethylalcohol. The results allow the conclusion that a person's ability to actively take part in traffic is impaired at least for several hours by the tested pharmaceutical substances. (Author)

56. MANOCHA, S.N. 1968.
Performance level and drug effects.
Psychopharmacologia. 12(2):123-126.

The effects of a mild dose of a tranquilizer, chlorpromazine, on the lever-pressing behavior of albino rats was studied. Twelve male rats were divided into 2 groups characterized by high and low performance on the basis of their lever-pressing scores in the Skinner box. The responses of the high performance group were significantly depressed by the drug. Habit strength and performance level operate antagonistically in determining the susceptibility of trained responses to the deleterious effects of drug. (Author)

57. McKENZIE, R.E. and L.L. ELLIOTT. 1964.
The effects of secobarbital and d-amphetamine on performance during a simulated tactical air mission.
In: 11th Annual Air Force Science and Engineering Symposium, Brooks Air Force Base, Texas, 20-22 Oct., 1964. Air Force Systems Command, Brooks Air Force Base, Texas. 30 pages.

The effects of secobarbital and d-amphetamine on pilot performance during simulated tactical air mission are reported. Secobarbital was used as a relaxant for sleep before flight, and d-amphetamine served as a stimulant to combat fatigue during flight. Air Force flight candidates were randomly assigned to treatments involving the drugs, a placebo, and control. Their ability under treatment to keep an aircraft on course was measured in a cockpit-console flight simulator. The residual effect of secobarbital alone, or in combination with d-amphetamine, harmed performance. Performance was enhanced by the use of d-amphetamine alone. (J.M.D.)

58. MELTON, C.E. 1964.
Physiological recording from pilots operating an aircraft simulator.
Federal Aviation Administration, AM-64-18, Oklahoma City, Okla.
12 pages.

Ten physiological records were obtained from each of six pilots performing simulated flight problems in a C-97 aircraft simulator. The pilots were given therapeutic doses of either a tranquilizer (meprobamate) or an antihistamine (chlorpheniramine) during three of the simulated flights, the others being training or control flights. Records were made of electrocardiogram, heart rate, respiratory rate, galvanic skin response, electroencephalogram (parietal-occipital), electroencephalogram (frontal-central) and lateral eye movements (electrooculogram). None of the variability of the above parameters, with the exception of the electroencephalograms (to be separately published), was ascribable to drug treatment. The techniques developed during this study are suitable for physiological recording from subjects in the work situation. (Author)

59. MENNEAR, J.H., et al. 1966.
The effects of scopolamine and atropine on the performance of an exercise-avoidance test by dogs.
Psychopharmacologia. 9(4):347-350.

Cholinergic blockade produced by scopolamine hydrochloride or atropine sulfate was found to disrupt the running behavior of dogs performing in exercise-avoidance test. The quaternized derivatives of these drugs were considerably less effective than the tertiary drugs and methyl atropine was effective only at a dose which was lethal to one of the animals tested. (Authors)

60. NAGLE, F.J., et al. 1963.
The mitigation of physical fatigue with "Spartase".
Federal Aviation Administration, CARI-63-12, Oklahoma City, Okla. 12 pages.

Pharmacological and clinical observations have indicated that Spartase--the aspartic acid salts of potassium and magnesium--takes part in the intermediary metabolism and moderates physical fatigue. In this study, attempts were made to evaluate effects of the drug on work capacity before and after episodes of physically fatiguing exercises. Work capacity was determined by a standardized treadmill test. The test was repeated after the subject had been running cross-country for a period of 60 min. and again after another such period of 40 min. In this way, effects of fatigue upon functional adaptability to stress became apparent. Spartase was taken orally in a prescribed dose for 2 weeks, whereupon the same testing procedure was reapplied. The results indicated that Spartase improved the endurance performance of untrained individuals engaging in extremely fatiguing physical work. It appeared to have no effect on highly trained individuals. (Author)

61. OLEYNIK, R.J. and R.D. SQUIRES. 1967.
The effects of normal sleep and drug-induced sleep on a visual alertness test.
In: Behavioral Problems in Aerospace Medicine. Advisory Group for Aerospace Research and Development, CONF-25, Brussels, Belgium. p. 7-1 to 7-3.

In view of the need for increased pharmacological knowledge and practice to maximize capabilities of pilots in sustained aerospace missions, a study was undertaken to evaluate various hypnotic sedatives with respect to quality of sleep elicited, arousal characteristics and psychophysiological performance. Focused on is the relative importance of the two distinct phases of sleep, the rapid eye movement phase (REM) and the nonrapid eye movement phase (NREM) in obtaining restful sleep. Human male subjects were exposed to ingestion of various hypnotic sedative drugs in moderate dosage after which they were asked to sleep. Drugs used included Chlordiazepoxide, Meprobamate, Methaqualone, Hydroxyme, and Pentobarbital. The expected result was to select a hypnotic sedative

better performance under meprobamate. Task loads, subject training, and performance feedback operated jointly to mitigate potential decremental effects of drugs and hypoxia. A separate "hangover" study revealed adverse effects of alcohol upon problem-solving time.

64. ROBERTS, M.H.T. and P.B. BRADLEY. 1967.
Studies on the effects of drugs on performance of a delayed discrimination.
Physiol. Behav. 2(4):389-397.

Monkeys were trained to perform a visual discrimination which involved retention of the parameters of stimuli during a variable time delay. Data are presented on the rate of learning and levels of control performance. The accuracy was recorded at each delay together with the tendency to score errors of commission or omission, the number of repetitive errors and the distribution of these and first-time errors within the session, the total responses and their latency. The effect on these performance measures of LSD 25 (lysergic acid diethylamide), psilocybin, 2-Brom LSD (2-Bromo lysergic acid diethylamide), 5-hydroxytryptophan, chlorpromazine, pentobarbitone, atropine, atropine methonitrate and physostigmine were compared with the effects of changes in the levels of motivation and distraction. LSD 25 disrupted accuracy at the longer delays, its effects on the other measures being similar to the distractive treatment. No evidence was found that these defects were related to the antagonism of 5-hydrocytryptamine except that 72 and 96 hr. after injection LSD 25, psilocybin and 2-Brom LSD significantly improved performance. The effects of chlorpromazine and pentobarbitone were similar while the disruptive effects of atropine were related to its peripheral actions. Physostigmine decreased accuracy during the first part of the session and subsequently caused an improvement. (Authors)

65. SMITH, P.W., et al. 1968.
Cholinesterase inhibition in relation to fitness to fly.
Aerospace Medicine. 39:754-758.

The characteristics of acute and chronic poisoning by organophosphorus cholinesterase inhibitors are described. Case histories representing acute poisoning episodes are superimposed on a state of chronic cholinesterase inhibition are presented. It is shown that the acetylcholine content of the brain of chronically-poisoned animals is high during the acute phase of poisoning and returns to control levels as tolerance develops, while the cholinesterase activity of brain tissue remains markedly depressed. The insidious and dangerous nature of chronic poisoning is emphasized. (Author)

66. TALLAND, G.A. and G.C. QUARTON. 1965.
Methamphetamine and pentobarbital effects on human motor performance.
Psychopharmacologia. 8(4):241-250.

Speed in 3 types of repetitive motor performance, and manual reaction time was tested at different levels of task complexity, on 36 students who served as their own control over repeated sessions, in which

drug suitable for long term aerospace or other military missions which would fulfill the following desirable criteria: (1) elicit restful sleep, presumably by keeping the normal REM/NREM ratio intact, (2) permit ease of arousal at any time after drug ingestion, and (3) cause no minimal impairment of performance at any time after taking the drug. Results indicated that Pentobarbital decreased REM time markedly over control-placebo levels; however, the other preparations had minimal or equivocal effects. The initiation of experiments using sodium gamma-hydroxybutyrate, a drug which produces a state of environment detachment much like REM sleep, in addition to having characteristics of rapid recovery and low toxicity, is reported. (S.C.W.)

62. PEARSON, D.W., et al. 1969.
A comparison of the behavioral effects of various levels of chronic Disulfoton poisoning.
Federal Aviation Administration, FAA-AM-69-19, Oklahoma City, Okla. 8 pages.

Exposure of general aviation pilots to toxic pesticides was reported as a possible cause of impairment of flying performance. Of particular concern and interest are the organophosphates that are known to be AChE (acetylcholinesterase)inhibitors. Inhibition of the enzyme AChE in the central nervous system affects ACh (acetylcholine) destruction, a normal process which follows nerve impulse transmission at the synapse, thus permitting excessive accumulations of ACh which could possibly interfere with memory and/or learning processes. The extent to which chronic cholinesterase inhibition in albino rats affects performance in a complex maze situation was explored. Disulfoton-exposed rats were capable of performing a mazerunning task with fewer errors and shorter trial times than control animals, although AChE levels for the most severely exposed group were more than 75 percent below normal. The latter was attained by the animals on 50-ppm of the poison. At this level an occasional animal had convulsions or severe tremors which temproarily incapacitated the rat. (Author)

63. PEARSON, R.G. and G.L. NEAL. 1970.
Operator performance as a function of drug, hypoxia, individual, and task factors.
Aerospace Medicine. 41(2):154-158.

Groups of 3 subjects received drug capsules (placebo, Librium, meprobamate) before and after overnight sleep. Alcohol and 12,000 ft. altitude treatments were introduced following initial, morning, task performance in a pressure chamber. Nine males performed under all experimental conditions which included appropriate alcohol and altitude controls. In a 3-hr posttreatment session, subjects rotated periodically among 3 tasks: tracking with concurrent meter and warning light monitoring, and reaction time assessed during rest periods, problem solving, and auditory vigilance. The principal and surprising finding was the general lack of drug-alcohol effects on performance. Analyses did reveal high individual and test day variability, and, under certain experimental conditions,

they received intravenous doses of methamphetamine, pentobarbital, and placebo adjusted to their body weight. The simpler the task the more likely was methamphetamine to speed up and pentobarbital to slow down performance rate. Compared with placebo, pentobarbital significantly affected rate in counter pressing, and tended to retard performance in a manual skill of finer co-ordination as well as in a cancellation test. Methamphetamine significantly speeded counter pressing with the dominant hand, but exercised that effect on the other hand only over the first minute of performance. Activity rate in the manual dexterity test was significantly faster on methamphetamine than on pentobarbital. Individual variability in work rate over successive time samples, and decrement over time, tended to be highest with methamphetamine. The favorable effect of methamphetamine on performance rate may thus stem primarily from an initial spurt that cannot be sustained, although it may revive after intervals longer than those investigated in the present study. No methamphetamine effect could be determined in several tests of reaction time, but pentobarbital slowed down responses, whether warning signals were provided or not. A slow rate in repetitive motor performance with barbiturates may, therefore, be partly attributable to a delay in monitoring cues for response. (Authors)

67. VALLETTA, G. 1967.
Dangers of pilots' self-medication - drugs which are apt to endanger a pilot's flight activities and are often taken without medical advice.
Rivista di Medicina Aeronautica e Spaziale. 30:54-88.

Survey of the occupational pathology of flight personnel inducing self-medication. The drugs chiefly used in self-medication are discussed and classified, according to their pharmacological action, and their dangerous effects on pilot performance in flight are studied. Some cases of dangerous self-medication in flight are reported. In conclusion, the necessity of controlling such medication by the proper medical authorities is stressed. (P. v. T.)

68. YAMAMOTO, K. and R. KIDO, 1965.
An analysis of drugs, acting on the central nervous system using animal experiments - association and dissociation between EEG and behavior.
Joint Publications Research Service, JPRS-28419, Washington, D.C. 28 pages.

Electroencephalographic and behavioral analysis of central nervous system (CNS)- acting drugs on cats, dogs, and monkeys are described. There were no essential differences in the normal EEG patterns between acutely and chronically affected animals, but deep sleep patterns and activated sleep patterns were not seen in acute animals. These patterns, due to differences in experimental conditions, were also observed after administration of some CNS-acting drugs. However, these results show the danger of misunderstanding consciousness levels if only acute EEG patterns are used as the criteria for judgment. After administration of reserpine, meprobomate, and barbiturates, differences of EEG and behavior among cats, dogs, and monkeys were not observed. However, "rage-like behavior" was observed only in cats following administration of chlorpromazine.

Also, after administration of morphine, cats showed continuous arousal: dogs showed narcosis: and monkeys showed intermediate responses between cats and dogs. (R.R.D.)

GENERAL STUDIES

69. ALLEN, M.E. and R.A. METTENS, 1968.
Aviation medicine translation: annotated bibliography of recently translated material. V.
Federal Aviation Administration, FAA-AM-68-7, Oklahoma City, Okla. 10 pages.

An annotated bibliography of translations of foreign-language articles is presented. The 24 entries are concerned with studies in aviation medicine, vestibular function, hearing, intercontinental flight, visual illusions, aviation visual and body temperature, heat center, head trauma, color vision, cholinasterase, nystagnus, aviation personnel selection and training, fatigue, pathology, circadian rhythm, alcohol vestibulo-oculomotor function, and time-zone shifts. Procedures for obtaining copies of the translations are included. (Author)

70. ALLUISI, E.A. 1969.
Research in performance assessment and enhancement.
Interim Technical Report. Louisville Univ, Ky. Performance Research Lab. 27 pages.

Results of prior studies on work behavior are presented and interpreted with regard to the equilavence of different durations of work, depending on the constraints and demands of the non-work or rest periods of the work-rest schedule: the effects on performance of the underlying psychophysiological diurnal rhythms and certain characteristics of such rhythms: the combined effects of sleep loss and demanding work-rest schedule; and the effects of infectious diseases on work behavior. (Author - TAB)

71. ANONYMOUS. 1964.
Human sciences in industry. Part I: ergonomics.
Great Britain Dept. of Scientific and Industrial Research, Warren Spring Lab. 141 pages.

Ergonomics, methods, facilities, equipment, and general references: systems of men and machines: visual inputs and processes: auditory inputs and processes, including speech production and intelligibility: other sensory inputs and processes: choice and interaction: body measurements, basic physiological capacities, basic and complex motor performance: design of controls and integration with displays: layout of panels and consoles: design of work space, equipment, and furniture: clothing and personal equipment: special environmental factors affecting performance: individual factors, work conditions, and task characteristics that affect behavioral efficiency: training

aids and devices: and other areas of psychological research pertinent to ergonomics are the 15 areas covered by this annotated bibliography. (E.E.B)

72. ANONYMOUS. 1969.
A study of factors that affect the performance of Army flight crew personnel.
Interim Report. Federation of American Societies for Experimental Biology, Washington, D.C. Life Sciences Research Office. 46 pages.

The study was conducted as a portion of a comprehensive review of the biomedical aspects of human performance, to provide the Office of the Chief of Research and Development with the most current information on the performance of the soldier. The report identifies the need for performance requirements and reviews the factors that influence the performance proficiency of Army flight crew personnel. (Author-TAB)

73. CANNON, D., et al. 1964.
Summary of literature review on extended operations.
George Washington Univ., Washington, D.C., Human Resources Research Office. 58 pages.

The report comprises a summary of a review of psychological literature pertaining to performance for extended periods of time. The material is organized into the following topics, as they relate to performance: sleep loss, temperature, nutrition, prolonged performance, drugs, stress, vibration, confinement, rest and personnel replacements, noise radiation, and clothing. In addition, a brief summary of vigilance literature is included. The inconclusive nature of the reviewed research precludes supporting or denying the thesis that troops can be expected to remain effective for 48 hours or longer. Endurance limits may vary significantly from one task to another. For this reason, suggestions for research are included. (Author - TAB)

74. DILLE, J.R. and E.W. MORRIS. 1966.
Human factors in general aviation accidents.
Federal Aviation Agency, Washington, D.C. Office of Aviation Medicine. FAA-AM-66-27. 9 pages.

During the twelve months ending October 31, 1965, there were 122 fatal general aviation accidents in the Western Refion in which the Regional Flight Surgeon's office was notified and the wreckage was located within one week. Autopsies were obtained on 86 pilots and blood alcohol determinations were obtained on 64 of these. No accidents were found to be definitely due to medical conditions but a psychiatric problem is the probable cause of one. In addition, 25 wore corrective lenses and 20 had other recorded physical defects. Drugs were found on three but were not found to be a causal factor: possibly significant barbiturate levels were found in two accidents. Blood ehtyl alcohol levels $\geq$30 mg % were found in 17(20.5%), five had levels greater than 250 mg %. The relationships

of experience, occupation, local reputation and time of day to alcohol involvement are discussed. Carbon monoxide, agricultural chemicals, and fatigue are among other causes found for fatal accidents. The role of medical conditions, alcohol and posticides are discussed for the few non-fatal accidents that were medically investigated. The development of human factors accident investigation is briefly discussed. (Author)

75. GIBBONS, H.L., et al. 1966.
Medical factors in 1964/1965 fatal aircraft accidents in the Southwest.
Aerospace Medicine. 37:1057-1060.

A nationwide study of 1963 fatal general aviation accidents with a 30% sampling revelaed 35.4% of the cases studied to have alcohol involvement. Medical investigation of fatal general aviation accidents in the Federal Aviation Agency's Southwest Region during 1964 and 1965 revealed measurable blood alcohol in 30.8% of the cases studied. This represents a 72% sampling of 162 fatal accidents. On 28% of the fatal accidents studied, blood alcohol was over 50 mg per 100 ml. In two cases, otherwise unremarkable levels of hypoxia plus carbon monoxide were thought to have been potentiated by alcohol. The combined effects of drugs, fatigue, alcohol, hypoxia, and other factors generally not recognized by an automobile-orientated public are considered to be a significant hazard in air transportation. (Author)

76. HARTMAN, B.O. and G.K. CANTRELL. 1967.
Mol: crew performance on demanding work/rest schedules compounded by sleep deprivation.
School of Aerospace Medicine, SAM-TR-67-99, Brooks AFB, Texas.
34 pages.

Thirteen subjects took part in a series of 12-day runs in an experiment on the effects of demanding work/rest schedules (4/2, 4/4, or 16/8 hours). On days 8, 9, and 10, subjects were deprived of sleep and worked continuously. No significant work/rest effects were seen until subjects were sleep-deprived. In general, subjects on the 16/8 schedule tolerated sleep deprivation better and recovered faster, as evidenced by psychomotor test scores and sleep reports. (Author)

77. HEINSTRA, N.W. 1970.
The effects of "stress fatigue" on performance in a simulated driving situation.
Ergonomics. 13:209-18.

78. KIRCHHOFF, H.W., editor. 1968.
Stress in flight and current problems of flight medicine.
Darmstadt, Wehr und Wissen Verlagsgesellschaft, West Germany.
123 pages.

80. KLEIN, K.E., et al. 1967.
Circadian rhythm in indices of human performance, physical fitness and stress resistance.
Aerospace Medicine. 39(5):512-518.

In order to estimate the existence and magnitude of rhythmic day-night variations in human performance, physical fitness and stress resistance, the following variables were measured every three hours over a full day-night cycle: The reaction time and its individual constancy, the maximal psychomotor coordination ability, the Schneider index, the predicted VO 2 max, the cardiovascular responses to tilting, the "time of useful consciousness" at simulated altitude. The twenty-four hours were divided into two experimental sessions so that limited sedentary activity could be maintained between the tests. All parameters (including body temperature, blood cosinophils, plasma-protein, aldolase and 17-OHCS) revealed relative rhythmic oscillations of the circadian type, the ranges of which varied for the group average between 1.4 percent (temperature) and 68 percent (17-OHCS) from the total twenty-four hour average. negative extreme values were shown during the night hours for all cardiovascular parameters; consequently the Schneider index and the VO 2 max predicted from the heart rate level during submaximal exercise had their positive peaks or best values at this time of the day. (Author)

81. LITSOV, A.N. 1969.
Experimental study of the diurnal periodicity in physiological functions and human performance during disruption of sleep and wakefulness patterns.
Space Biol. and Med. 3(4):85.

A drastic alteration of work and rest cycles caused a gradual restructuring of physiological functions and the performance pattern of six healthy pilots used as test subjects. The restructuring included three stages: latent, apparent and deep. The rate with which different functions of the human body adjusted to a new environment varied: the EEG and simple motor reactions changed with the highest rate whereas autonomic functions and highly coordinated mental activity changed with the lowest rate. The restructuring of diurnal periodicity under experimental conditions was considerably affected by the pettern of physical and mental activity and the sleep of the test subjects and their motivation. The dynamics of restructuring of physiological functions, performance and sleep of human beings should be considered as the best indication of human adaptation to an altered pattern of their activity. (Author)

82. PHILLIPS, P.B. 1967.
Human behavior patterns under stress.
Aerospace Medical Association, 1967 Annual Scientific Meeting, Washington, D.C., April 10-13, 1967, Preprints of scientific program. Washington, D.C., American Medical Association. 338 pages.

83. SENDROY, J. 1968.
Biochemical approach to stress problems.
Naval Medical Research Inst., Bethesda, Md. Rept. 18.

Consideration is given to the meaning of, and variation in, stress and an attempt is made to arrive at an acceptable biomedical definition of stress. Attention is called to the mission, activities

and responsibilities of the Bureau of Medicine and Surgery of the Department of the Navy, and emphasis is laid on the fact that most of these have to do with the physical and mental health of personnel under quite stressful conditions of environmental and/or operational origin. Many physical, physiological and psychological stresses are encountered in Navy and/or military service and give rise to unique problems which are the subjects of research in the Navy's Biomedical Laboratories Responses to stress, regulated by physiological systems, may be studied as biochemical manifestations of the organism's reaction to changes in internal and external environment. In the consideration of disease as a form of stress, the role of the clinical chemist should be viewed as that of a biochemist rather than of a specialist isolated in the clinical laboratory. (Author - TAB)

84. SMILEY, J.R. 1967.
Aeromedical incidents amongst Canadian Forces pilots: a survey.
Institute of Aviation Medicine, Toronto (Ontario). Rept. 67.
24 pages.

A probability sample of 300 Canadian Forces pilots was used in a questionnaire survey regarding their experience with aeromedical incidents. Peripheral information was sought about drug usage, flying with hangovers, hemorrhoids, and the role of flight surgeons as seen by the pilots. From 224 returns (a 75% response) it was found that 97% of the pilots had had at least some aeromedical incidents in flight. The predominant cause was vertigo and/or disorientation. This cause factor also predominated when related to incidents threatening the safety of the aircraft. Findings related to drug usage and hemorrhoids were negative. However, 60% of the pilots had flown at least a few times with hangovers. Flying with hangovers was found to be significantly associated with higher incidence of all types of aeromedical incident. About 40% of pilots failed to report any of their aeromedical experiences to the flight surgeon. More significantly, 70% of those having experienced hazardous incidents failed to report these specific incidents.

85. TINSLEY, J.H. 1969.
An investigation of physiological correlates of vigilance performance.
Naval Postgraduate School, Monterey, Cal. 36 pages.

The document is concerned with a theory that man typically cannot perform a vigilance task over extended periods of time without experiencing a decrement in performance, often as rapidly as fifteen minutes after commencing the task. This research was directed toward determining if some of mans physiological functions are correlated with his performance in a vigilance task. (TAB)

86. TITIUS, H. 1968.
Stress and flying from the point of view of the air force physician.
In: Stress in flight and current problems of flight medicine. Edited by H. W. Kirchhoff. Darmstadt, Wehr and Wissen Verlagsgesellschaft, West Germany. p. 22-26.

Discussion of the admissible degree of the pilot flight stress not resulting in hazardous consequences, and possible measures which should be taken in the air force to relieve this stress. Based on several actual examples, the danger of overcharge and fatigue of jet pilots is discussed. It is demonstrated that these symptoms in most cases result in longer reactions, decreased attention and performance, and panic. Several measures are suggested to increase the resistance of the flying personnel to psychic and flight stress. (O.H.)

87. TOBIAS, J.V. 1964.
Aviation medicine translations: annotated bibliography of recently translated materials, II.
Federal Aviation Agency, FAA-AM-64-18, Oklahoma City, Okla.
13 pages.

An annotated bibliography of translations of foreign-language research articles is presented. The 27 listed entries are concerned with studies of auditory fatigue, auditory malingering, voluntary nystagmus, vestibular function, objective and subjective fatigue, drugs, and forensic science. Procedures for obtaining copies of the translations are included. (Author)

EFFECTS OF STRESS ON THE RHYTHMS OF PLASMA STEROIDS

Studies dealing with changes in the rhythmic patterns of hormone concentrations in the blood which are induced by environmental stressors or psychological tension are represented by this collection. Pharmacological and chemical agents affecting changes in plasma steroid levels are excluded.

1. ADER, R., S.B. FRIEDMAN and L.J. GROTA, 1967.
"Emotionality" and adrenal cortical function: Effects of strain, test, and the 24-hour corticosterone rhythm.
Anim. Behav. 15:37-44.

Open field testing of rats and mice did not yield significant behavior-steriod correlations. In a second experiment albino and hooded rats were observed in a reaction-to-handling situation and an open-field at the peak and trough in the previously determined 24-hour rhythm in adrenal cortical activity. Strain differences were observed in the reaction-to-handling test and to a lesser extent in the open-field, and were independent of the time of testing. Hooded animals had heavier adrenal glands than albinos, but neither adrenal weight nor plasma and adrenal corticosterone values were related to emotionality. The plasma corticosterone response to behavioral testing varied as a function of the test and time at which it occurred. (Authors)

2. ADER, R., and S.B. FRIEDMAN. 1968
Plasma corticosterone response to environmental stimulation: Effects of duration of stimulation and the 24-hour adrenocortical rhythm.
Neuroendocrinology 3: 378-386.

Among the variables which may affect the response to environmental stimulation are the intensity and duration of the stimulation, the time following stimulation when adrenal measurements are made, and the point during the circadian adrenocortical rhythm at which stimuli are presented. Plasma corticosterone response was measured in group-housed rats sacrificed sequentially at the crest or trough in the adrenocortical cycle. The animals sacrificed at the crest showed a 50 percent rise and those sacrificed at the trough showed a 5-fold increase in corticosterone levels between the first and last animals sacrificed. In a second experiment, individually housed animals were transferred to a second cage for 5 - 240 seconds, then returned to their home cage and sacrificed 15 minutes later. Five seconds of stimulation was sufficient to cause significant elevation of corticosterone levels in animals sacrificed at the crest and at the trough in the adrenocortical cycle, but the increase was relatively greater when the stimulation was superimposed on the trough. In a third experiment, groups of rats, housed two per cage, were killed at the crest or trough in the adrenocortical cycle 5 to 60 minutes after either 5 seconds or 3 minutes of stimulation. Results indicated that though there may be no difference in the maximum corticosterone levels attained, there may well be differences in the time course of the plasma corticosterone responses to different durations of stimulation and the point in the 24-hour adrenocortical rhythm at which the stimulation is superimposed. These findings raise several questions as to the definition of adrenocortical reactivity. (A.R.T.)

3. ADER, R. 1969
Early experiences accelerate maturation of the 24-hour adrenocortical rhythm.
Science 163:1225-1226.

4. ALLEN, C. and J.S. KENDALL, 1967
Maturation of the circadian rhythm of plasma corticosterone in the rat.
Endocrinol. 80:926-930

No abstract available.

5. ANDERSON, E. 1966
Adrenocorticotrophin-releasing hormone in peripheral blood - increase during stress.
Science, 152: 379-380.

Experimental study reporting that significant amounts of adrenocorticotrophin-releasing hormone appear in the peripheral blood of rats under conditions of physiological stress. It is found that increased antidiurotic activity is associated with the appearance of this neurohormone. The experimental conditions are described in which stressed and unstressed rats are tested for hormone activity. It is concluded that the neurohormone presumably enters the general circulation by way of the portal vessels of the anterior pituitary gland.(M.L.)

6. AUSTIN, F.H., T.J. GALLAGHER, C.A. BRICTSON, B.D. POLIS, D.E. FURRY, and C.E. LEWIS, Jr. 1967.
Acromedical monitoring of Naval aviators during aircraft carrier combat operation.
Aerospace Med. 38: 593-596.

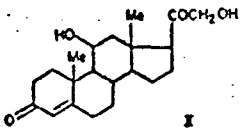
No abstract available.

7. BARKALAYA, A.I. 1971
Changes of plasma corticosterone rhythm and of glycemia in rats during stress and hormonal effects.
[Izmenenie ritma kortikosterona plazmy i glikemil u krys pri stressovykh i gormonal'nykh vliyaniyakh.]
Probl. Endokrinol. 1762: 75-78.

A complex study of the rhythm of corticism and glycemia was carried out in albino rats in conditions of total electrostimulation, total irradiation, administration of adrenalin and aCTH. Dynamics of daily rhythm of corticism and glycemia of intact rats proved to be synchronous: increasing gradually from 11 a.m., the concentration of corticosterone and blood glucose showed a relative stabilization at a high level from 2 to 5 p.m. and displayed some reduction by 8 p.m. In general electrostimulation and total gamma-irradiation of rats the peak of hypercorticism occurred earlier than that of hyperglycemia. Repeated hypercorticism developing 3 hr. after a brief hypercorticism pursues a parallel course with the hypercorticism rhythm of intact rats. An inhibition of decline of stressor hyperglycemia begins from this period, which is apparently conditioned by the process of

gluconeogenesis. Dynamics of hypercorticism and hyperglycemia in rats to which a single dose of adrenalin and ACTH was given is analogous to that in the extreme effects during the first 2-3 hr. A stable hypocorticism and glycemia approaching the normal is noted in experiment with adrenalin. ACTH administration was followed by hypocorticism in 5 hr., and later both the corticism and glycemia tend to approach the rhythm of intact rats. (P.L.W.)

8. BARKALAYA, A.I. 1971
Changes of corticosterone rhythm and glycemia in rats under stress and hormonal effects.
Probl. Endokrinol. 17:75-78.



I

The dynamics of daily rhythm of blood corticosterone (I) content and glyeemia developed synchronously in rats, gradually increasing from 11 a.m., stabilizing about 2 p.m. - 5 p.m., and then decreasing somewhat at 8 p.m. Whole-body electrostimulation (2.5 mA for 2 min) and γ-irradn. (750 R) caused peak hypocorticism at 30 min-1 hr earlier than the peak value of hyperglycemia (2 hr). Temporary hypocorticism was followed 3 hr later by a second hypercoricism which paralleled the rhythm of hypercorticism in intact rats. During rest period stress hyperglycemia began to decrease, probably due to neoglucogenesis. The dynamics of I action on glucose level in rats during a single adrenaline or ACTH administration were analogous to those during extreme effects in the first 2-3 hr. Later in the adrenaline experiment there was a sharp decrease in the content of I and glycemia returned to normal. ACTH administration was followed by a low level of I for 5 hr. Later the dynamics of both blood I and glucose approached the rhythm in intact rats. (BJJR)

9. BERTIN, R. 1969
Adrenal and plasma corticosterone levels in rats adapted to various temperatures.
Compt. Rendu, D.163:2108-2112

Long-Evans rats were adapted to 5, 20, or 30° or exposed to daily rhythmic temperature variations between 5 and 30°. In rats adapted to cold, the corticosterone levels in the adrenals and in the plasma were elevated even after four months. During adaptation to heat, however, the (I) concentrations in adrenals and plasma initially decreased; after four months, the concentrate in the adrenals was still half that of normal animals, but the concentrate in the plasma was norma. In rats exposed to temperature fluctuations, the corticosterone concentrate in the adrenals remained nearly constant, while the concentrate in the plasma steadily rose and after four months was 1.5-2 fold higher than in the controls. (Kurt H. Zingraf)

10. BROWN, GREGORY M., DON S. SCHALACH and SEYMOUR REICHLIN. 1971
Patterns of growth hormone and corticol responses to psychological stress in the squirrel monkey.
Endocrinology 88:956-963

Several recent studies showed that growth hormone (GH) secretion responds acutely to a variety of stressful stimuli in primates. In the present study GH responses to capture, chair restraint, intense sound and aversive conditioning were systematically examined in the squirrel monkey. Plasma cortisol was used as an index of pituitary-adrenal activation. Dissociation of pituitary-adrenal from GH stress responses indicates that specific and separable control mechanisms are involved. An intense sound stimulus was a relatively ineffective stressful stimulus since it was followed by a rise in GR in only 1 of 5 chair restrained animals. During aversive condition ng GH elevation was seen in animals only during training, with no elevation occurring in animals which successfully avoided shock. GH stress responses are reduced during psychological adaptation. Following capture (which proved to be the most consistently stressful stimulus), levels of both GH and cortisol were significantly higher than resting levels (10.8 vs 3.9 ng/ml and 755.7 vs 404.9 µg/100 ml. respectively); dissociation of hormone response occurred during chair restraint, with GH falling to resting levels (5.3 ng/ml) and cortisol continuing to rise to a plateau at 60-90 min (1090.6 µg/100ml).

11. CLAUS WALKER, JACUQLINE L. 1967
Plasma 17 hydroxycorticosteroids in health subjects after water immersion of twelve hours' duration.
Aerosp. Med. 38: p.459.

The Plasma 17 hydroxycorticosteroids were measured by the Nelson and Samuels method in six healthy subjects before and after water immersion at 93°F of 12-hr duration. The test was repeated several days after the first immersion. There was no significant difference in the concentration of 17 hydroxycorticosteroids in the plasma withdrawn before or after water immersion. (Author)

12. CONNOR, R.L., S. LEVINE, and J.V. DANELLIS 1971
Stress, fighting and neuroendocrine function.
Nature, 234: 564-566.

Plasma concentrations of pituitary adrenocorticotrophic hormone (ACTH) and adrenocortical steroids in rats after testing in the shock-induced fighting paradigm was examined. The investigations provide data consistent with the view that psychological aspects of the stressful situation are important in determining the effects of shock on physiological function. The data indicate that the pituitary-adrenal response can be attenuated by the expression of an organized pattern of behavior. (G.R.)

13. CONROY, R.T., B.D. HUGHES, and J.N. MILLS 1968
Circadian rhythm of plasma 11-hydroxycorticosteroids in psychiatric disorders.
Brit. Med. J. 3:405-407

Studies of the circadian rhythm in plasma 11-OHCS levels showed that a subgroup of affective psychotics ahd higher plasma 11-OHCS values as compared with schizophrenic and other psychotic subgroups and a somewhat less regular rhythm. One patient with depression who was studied over 48 hr periods showed a reduction in plasma 11-OHCS levels with clinical recovery. An accentuated fall and rise in plasma 11-OHCS values in the night and early morning samples, respectively, was observed in the schizophrenic subgroup. (Authors)

14. CONROY, R.T., A.L. ELLIOTT, J.N. MILLS. 1970
Circadian rhythms in plasma concentration of 11-hydroxycorticosteroids in men working on night shift and in permanent night workers.
Brit. J. Ind. Med. 27: 170-174.

Plasma 11-hydroxycorticosteroids were determined in day and night shift workers of a factory and in night workers of a newspaper plant. Day workers showed maximum values at the beginning of their work and the newspaper workers when they awakened around 2 p.m. Night shift workers showed great variety of pattern and no clear circadian rhythm. Adrenal cortical activity is adaptable to diurnal habits only if those are universal and lifelong, while adjustments to temporary shift work are more unusual. (A.L. Reeves)

15. COURTNEY, G.A. and S.F. MAROTTA. 1972
Adrenocortical steroids during acute exposure to environmental stresses. I. Disappearance of infused cortisol.
Aerosp. Med. 48: 46-51.

The removal rates of injected cortisol from the plasma of dogs exposed to a wide variety of environmental stresses were investigated. Male mongrel dogs were divided into six groups: ground level (ambient air, control, hypoxia, hyperoxia, heat, cold, and positive pressure breathing.) Blood samples were withdrawn at various times after cortisal infusion and the plasma was analyzed for 17-OHCS. The disappearance of 17-OHCS in plasma was calculated according to an open two-compartment model with a fast and slow component. Rate constants to and from compartments, volumes of compartments, half-lives and metabolic clearance rates were calculated. No significant differences in any of the calculated values were observed between the stressed and the control groups or among any of the experimental groups. The data suggest that the discrepancies reported in the literature relative to elevation or depression of peripheral plasma 17-OHCS during stress are due to the differences in the response of the hypothalamic-pituitary-cortical system and not necessarily the subsequent rate of 17-OHCS removal.

16. COURTNEY, G.A. and S.F. MAROTTA 1972
Adrenocortical steroids during acute exposure to environmental stresses II. Uptake and release of infused cortisol by the hind limbs of dogs. Aerosp. Med. 48:52-55.

This investigation was undertaken to determine the influence of various environmental stresses on the uptake and release of 17-OHCS by the hind limbs of dogs infused with cortisol. The amounts of 17-OHCS presented to and released from the femoral bed of animals exposed to ground level (control, hypoxia, hyperoxia, heat, cold, and positive pressure breathing) were dependent primarily upon blood flows. The extraction of steroids by these tissues was not unduly affected by the stresses, thus suggesting that "tissue utilization" was not altered by the stresses. The steroids taken up by the tissues were released when the arterial concentrations were low, and/or the tissue binding sites had been saturated. There was some indication that the markedly elevated venous pressures observed during positive pressure breathing may affect the release of steroids from the tissues.

17. CRAVEN, C.W. and C.S. SMITH. 1955
Steroid excretion in airmen under stress.
J. Aciat. Med. 26:200

18. CRITCHLOW, V. 1963
The role of light in the neuroendocrine system.
In: A.V. Nalbandov, ed. Advances in Neuroendocrinology.
University of Illinois Press, Urbana, Ill.

19. CSALAY, L., G. CSAKVARY, R. FRENKL 1969
Factors regulating blood corticosterone level in animals subjected to chronic alcohol treatment.
Polypeptide Horm., Proc. Congr. Hung. Soc. Endocrinol. Metab. 4:141-145

Rats receiving increasing doses of ethanol [64-17-5] in drinking water (5, 10, 15 and 20% EtOH during the 1st, 2nd, 3rd and 4th through 6th week, resp.) had higher blood corticosterone (I) [50-22-6] levels than untreated controls. The level of I dropped to normal on discontinuation of the EtOH treatment for 24 hr. EtOH-treated rats stressed with either i.p. injection of 0.8 ml of 20% EtOH/100 g. or by a swimming exercise had less of an increase in I levels than the untreated rats. EtOH -treated rats had greater blood I elevation in response to i.p. administration of 0.1 IU of ACTH than did controls. The diminished response to acute stress by EtOH-treated rats may be due to functional changes in the pituitary gland and hypothalamus rather than the adrenal glands.

20. DLUSSKAIA, I.G. 1966
[Patterning of adrenocortical hormone response in rats exposed to various actions].
Fiziol Zh. SSSR Sechenov 52:286-290.

21. DUNN, J. and L. Scheving, 1971
Plasma corticosterone levels in rats killed sequentially at the "trough" or "peak" of the adrenocortical cycle.
J. Endocrinol. 49: 347-348.

22. ELMADJIAN, F., and E. FORCHIELLI, 1965
Characterization of hormonal steroids of the chimpanzee. Changes observed in adrenal cortical function during simulated and actual space flight.
In: L. Martini and A. Pecile, eds. Hormonal steroids, biochemistry and therapeutics: Proceedings of the first international congress on hormonal steroids, N.Y. Acad. Press. p.535-544.

23. FISKE, V.M., and S.E. Leeman. 1964
Observations on adrenal shythmicity and associated phenomena in the rat: effect of light on adrenocortical function; maturation of the hypothalamic neurosecretory system in relation to adrenal secretion.
Ann. N.Y. Acad. Sci. 117: 231-234.

24. FOX, M., B.J. MURAWSKI, A.F. BARTHOLOMAY and S. GIFFORD, 1961
Adrenal steroid excretion patterns in eighteen healthy subjects.
Psychosom. Med. 23: 633-640.

25. FROEBERG, J. CLAES-GORAN KARLSSON, LENNART LEVI, LARS LIDBERG, and KENNETH SEEMAN. 1970
Conditions of work: psychological and endocrine stress reactions.
Arch. Environ. Health 21:789-797.
Psychosocial stressors in modern working life and measurement of their psychophysiological effects are briefly discussed and three stress studies presented. First, officers and soldiers were exposed to a stressful 75-hr. vigil. Significant stress reactions occurred with respect to erythrocyte sedimentation rate, protein-bound iodine, serum Fe level, ECG pattern, behavior, and catecholamine excretion. Pronounced circadian rhythms and significant psychophysiological correlations were demonstrated. The remuneration of salaried invoicing clerks was abriptly changed to piecewages. The subjects exhibited a sharp rise in performance but also an increase in discomfort ratings and catecholamine excretion. Office clerks were moved to and from various types of offices. In general moving from a conventional office to an office landscape was accompanied by an increase in fatigue ratings and catecholamine excretion. The implications of these findings for environmental health are briefly discussed.

26. GIBBS, F.P. 1970
Circadian variation of ether-induced corticosterone secretion in the rat.
Amer. J. Physiol. 219:283-292.

No abstract available.

27. GOODICKE, W., C. GRAFF, R. BAUNMAN, E. NAUMANN, H. ZIPRIAN. 1971
Effect of an experimentally induced physical stress situation on serum lipids, plasma cortisol and 3-methoxy-4-hydroxymandelic acid excretion in essential hypertension.
Deut. Gesundheitser. 26:1973-1976.

Patients with essential hypertension and normotensive controls (with systolic and diastolic blood pressures of 140 and 90 mm Hg. respectively) were arranged in three groups: normotensives without stress, normotensives with stress, and hypertensives with stress. Before and after subjection to experimental psychic stress, urinary 4-hydroxy-3-methoxymandelic acid (HMMA) excretion and the concentration of cortisol, free fatty acids (FFA) triglycerides, phospholipid, and cholesterol was determined in the plasma. Hypertensives reacted to stress by increased excretion of HMMA and increased concentrations of cortisol, FFA and phospholipids. Stressed normotensives reacted by an increased concentration of cortisol and FFA and decreased concentrations of trigylcerides, while unstressed normotensives showed a decrease of cortisol, FFA nad tryclyceride concentrations. Changes in triglycerides of the control group are not significant, while the decrease of cortisol and of FFA is attributed to a daily rhythmic change in secretion. Essential hypertensives react more sensitively to psychic stress than normotensives. (PCS).

28. GOLIKOV, P.O. and A.M. POPOVA. 1969
[Corticosterone secretion and some indices of stress reaction]
Pat. Fiziol. Eksp. Ter. 13:71-72.

No abstract available.

29. GONCHAROV, N.P. 1966.
Blood plasma 17-oxycorticosteroid level in rhesus macaques and hamadryads (Papio hamadryas) and the changes it undergoes due to neuroemotional factors.
[Uraven' 17-oksikortikosteroidov v plazme krovi makak rezus i pavianov gonadrilov i ego izmenenie pri nervno-emotsional'nom vozdeistvii].
Byul. Eksp. Biol. Med. 61:54-57.

The concentration of 17-oxycorticosteroids in male rhesus macaques averaged 34 $\pm$ 1.3 mg %; in females, 44 $\pm$ 1.2 mg%; in male and female hamadryads, 41 $\pm$ 1.5 mg% and 52 $\pm$ 1.5 mg% respectively. Variable reaction of the adrenal cortex to intravenous injection of ACTH was found in different species of monkeys. In rhesus macaques the maximum increase in 17-oxycorticosteroids was registered 1 hr after the injection of the preparation; in hamadryads, in 2 hr. Nembutal anesthesia prevents the development of the stress conditions. The neuroemotional strain in monkeys brings about a marked increase in the hormonal function of the adrenal cortex. (Author)

30. GOTTFRIED, I., H. LEWENTHAL and S. GOLDBERG. 1968
Free 11-hydroxycorticosteroids in plasma and urine in pregnancy and cases of stress.
Ameri. J. Ostet. Gynec. 102: 924-927.

No abstract available.

31. HALE, H.B., C.H. KRATOCHVIL, and J.P. ELLIS,Jr. 1958
lasma corticosteroid levels in aircrewmen after long flights.
J. Clin. Endocr. 18: 1440-1443.

32. HALE, H.B., J.P. ELLIS and C.H. KRATOCHVIL. 1959
Effect of piloting supersonic aircraft on plasma corticosteroids and bicarbonate.
J. Appl. Physiol. 14: 629.

No abstract available.

33. HALE, H.B. 1965
Plasma corticosteroid changes during space equivalent decompression in partial-pressure suits and in supersonic flight.
In: Martini, L. and Pecile A. eds. Hormonal steroids, biochemistry, pharmacology and therapeutics: Proc. of first international congress on hormonal steroids. N.Y. Acad. Press. Vol. 2.

34. HAUS, E. and F. HALBERG. 1970
Cirannual rhythm in level and timing of serum corticosterone in standardized inbred mature C-mice.
Environmental Research, 3:81-106

Demonstration of circannual variations in serum corticosterone levels in Belb/c. mice. High values are found during the winter months and low values in late spring and summer. Cosiner analysis of the circadian rhythm of serum corticosterone during different times of the year shows a change in the circadian aerophase (crest) from about 43° in February to 95° in May. This change is evident after a seven-day standardization span at relatively constant temperatures. This circannual variation in circadian aerophase is compared with the time required for a phase shift after an abrupt change in lighting regimen: after a 180° shift of the lighting regi en, the change in the serum corticosterone aerophase reaches 45° in less than three days, over 100° in four days, and almost a full 180° in seven days. Therefore, the circannual variation in the circadian system phase of the adrenal cycle shown in this study cannot be regarded as an incomplete phase shift such as occurs shortly after an abrupt shift of the lighting regimen. The underlying mechanisms of this presumably partly intrinsic circannual biorhythm await further study. (MVE)

35. HAMANAKA, Y., H. MANABE, H. TANAKA, Y. MONDEN, T. UOZUMI, K. MATSUMOTO, 1970
Effects of surgery on plasma levels of cortisol, corticosterone and non-protein-bound cortisol.
Acta. Endocrinol. 64:439-451.

The diurnal variation in plasma cortisol, corticosterone, and nonprotein-bound cortisol was investigated in samples obtained from preoperative chronically ill (control) subjects and patients during and following major surgery. A fluorimetric method using clution chromatog. on Amberlite IRC-50 and the equilibrium dialysis method were used for the determinations. The diurnal variation in plasma cortisol of the preoperative control subjects reached a peak (17.3 ug/100 ml) between 10 p.m. and midnight. The maximum value in the level of corticosterone (0.6 ug/100 ml) was observed at 6 a.m. Surgery caused a steep rise in plasma cortisol, showing a maximum value (30.0 ug/100 ml) 2-4 hr. after the end of the operation. Although the average of the morning levels of plasma cortisol returned to the control values within 4-5 days, the evening levels did not return till the sixth day after the operation. The response of plasma corticosterone in the surgery group paralleled the change in plasma cortisol, though the increase in the corticosterone concentration was significantly greater than that of cortisol. The percentage of nonprotein-bound cortisol in the plasma increased significantly during and for four days following the operation, concomitant with the increase in the levels of plasma cortisol. Stressful situations are apparently associated with markedly increased plasma levels of biologically active cortisol. (RCTT)

36. HENINGER, G.R., R.K. MCDONALD, and W.R. GOFF, 1969
Diurnal variations in the cerebral evoked response and EEG. Relations to 17-hydroxycorticosteroid levels.
Arch. Neurol. 21: 330-337.

No abstract available.

37. HIROSHIGE, T. and S. SAKAKURA, 1971
Circadian rhythm of corticotropin-releasing activity in the hypothalamus of normal and adrenalectomized rats.
Neuroendocrinology, 7:25-36

Circadian periodicity of the hypothalamic content of corticotropin-releasing factor (CRF) was determined in normal and adrenalectomized male rats, using the intrapituitary microinjection method. The CRF activity in the rat hypothalamus showed a definite circadian variation, having the peak value of 6 p.m. and the minimum at 8 a.m. under the lighting schedule used here (light between 6 a.m. and 7 p.m. followed by 11 hr of darkness). A close temporal relationship with a definite phase shift was observed between the CRF activity and plasma corticosterone level. The circadian rhythm of the pituitary-adrenal axis is a direct

reflection of the rhythmicity of CRF activity in the median eminence. Furthermore, the persistent periodicity observed in the CRF activity in the absence of circulating corticosterone suggests that the dominating mechanism for the control of the circadian rhythm of CRF activity is of neural origin, being independent of the negative feedback mechanism.(PLW)

38. HODGES, M.S. Jr. 1970
Circadian rhythm in plasma corticosterone concentration and pituitary adrenocorticotrophic response to stress in the betamethasone treated rat.
Brit. J. Pharmacol. 39: 192-193.

No abstract available.

39. JAKÓBSON, T., M. BLJMENTHAL, and H. HAGMAN 1969
The diurnal variation of urinary and plasma 17-hydroxy-corticosteroid (17-OHCS) levels and the plasma 17-OHCS response to lysine-8-vasopressin in depressive patients.
J. Psychosom. Res. 13:363-375.

No abstract available.

40. JONES, M.T., P.K. BRIDGES, and D. LEAK 1970
Correlation between psychic and endocrinological responses to emotional stress.
Progr. Brain Res. 32: 325-335.

41. KATZ, F.H. and I.L. SHANNON 1964
Identification and significance of parotid fluid corticosteroids.
Acta. Endocr. 46: 393-404

No abstract available.

42. KLEIN, K.E., H.M. WEGMANN and H. BRUNER
Circadian rhythm in indices of human performance, physical fitness stress resistance.
Aerosp. Med. 39: 512-518.

In order to estimate the existence and magnitude of rhythmic day-night variations in human performance, physical fitness and stress resistance, the following variables were measured every three hours over a full day-night cycle: the reaction time and its individual constancy, the maximal psychomotor coordination ability, the Schneider index, the predicted VO2 maximum, the cardiovascular responses to tilting, and the "time of useful consciousness" at simulated altitude. The 24 hr. were divided into two experimental sessions so that limited sedentary activity could be maintained between the tests.

All parameters (including body temperature, blood eosinophils, plasma-protein, aldelase and 17-OHCS) revealed relative rhythmic oscillations of the circadian type, the ranges of which varied for the group average between 1.4% (temperature) and 68% (17-OHCS) from the total 24 hour average. Negative extreme values were shown during the night hours for all cardiovascular parameters; consequently the Schneider index and the VO2 maximum predicted from the heat rate level during submaximal exercise had their positive peaks or best values at this time of the day. This phenomenon seems to be an "artificial" effect of the method determining physical fitness and probably is not identical with the course of "fitness" itself. However, "true" positive night peaks were found for the altitude tolerance. The significance of the results for the applicability of functional tests and human efficiency during stress is discussed. (Authors)

43. KNAPP, M.S., P.M. KEANE and J.G. WRIGHT 1967
Circadian rhythm of plasma 11-hydroxycorticosteroids in depressive illness, congestive heart failure and Cushing's syndrome.
Brit. Med. J. 2:27-30.

Plasma 11-hydroxycorticosteroids were measured in plasma samples taken at 4-hourly intervals over 24 hr. from patients with depressive illness, congestive heart failure, and Cushing's syndrome. In those with depression a normal circadian rhythm was found, except at 0400 hr. In congestive heart failure and Cushing's syndrome it is unusual to have any obvious rhythm. (STL)

44. KOJIMA, A., T. KAKIZAKI and Y. NHYAMA, 1967
Catecholamine and 17-ketogenic steroid excretion and plasma-11-hydroxycorticosteroid level in new workers with special reference to job adaptation.
Ind. Health. 5:1-8

The values of adrenaline [epinephrine] excretion and plasma 11-hydroxycorticosteroids of the new workers at the first month were significantly higher than those of the senior members in the same working place, and than their own values at the third month. As adrenal cortical and medullary hormone levels have been reported to be elevated in mental or emotional stresses, it was assumed that the new workers might get into some mental or emotional stress perhaps due to their first experience of the work at factory and adapted to such a stress after three months of work. (Authors)

45. KRATOCHVIF, C.H. 1968
Biological rhythms.
In: Aeromed. aspects of troop transport and combat readiness.
(N69-26833 14-04)

The perinnent literature with regard to circadian rhythms is reviewed and research areas are identified where further effort is required. The problems which specifically relate to the problem of troop transport, and the closely related problem of aeromedical evacuation, are emphasized. The nature of circadian rhythms, the effect of east-west flight versus west-east flight upon readjustment to the new time zone, the altered response to stress brought about by a shift in time zones, and the methodology of analysis in such studies are discussed. It is pointed out that researchers in the field of sleep studies should work more closely with investigators of circadian rhythms. (PAD)

46. KRIEFER, D.T., A.I. SILVERBERG, F. RIZZO and H.P. KRIEGER. 1963
Abolition of circadian periodicity of plasma 17-OHCS [17-hydroxycorticosteroid] levels in the cat.
Amer. J. Physiol, 215:959-967.

A circadian pattern of plasma 17-OHCS levels has been demonstrated in the cat. Atropine, administered systemically to cats just prior to the time of the expected circadian rise, blocks this elevation. Atropine does not alter the circadian pattern when administered at other times in the 24-hr period. Similar results have been observed with the systemic administration of sodium thiamylal. Phynoxybenzamine hydrochloride administered just prior to the time of the expected circadian rise is ineffective in blocking this rise. Neither atropine nor sodium thiamylal interfers with the adrenal response to ACTH, the pituitary-adrenal response to lysine vasopressin, the hypothalamic-pituitary-adrenal response to either insulin hypoglycemia or to Piromen administration. Atropine and sodium thiamylal affect the circadian periodicity of plasma 17-OHCS levels by a direct action on the CNS [central nervous system] and do so at one critical period in the 24-hr cycle. Different CNS mechanicms and/or structures are involved in the regulation of circadian periodicity of adrenal steroid levels as opposed to stress initiated adrenal cortical responses. (Authors.

47. KRIEGER, D.T., J. KREUZER, F.A. RIZZO, 1969
Constant light: affect on circadian pattern and phase reversal of steroid and electrolyte levels in man.
J. Clin. Endocrinol. Metab. 20:1634-1648.

An adult male and an adult female subject were confined to ths hospital for the entire period of the study. Circadian periodicity of plasma 11-hydroxy-corticosteroids (I), urinary volume and Na, K, Cl and creatinine excretion were established by determinations performed every four hours over a 48-hr period, commencing four days after the start of the

calcd. diet. Constant light with normal daily activity and nocturnal sleep from 12 midnight to 8 a.m. for a period of 21 days was associated with a normal circadian pattern of plasma I levels and of urinary excretion of K as well as normal a.m./p.m. urinary volume rates. Na. and Cl. excretion patterns in all studies were essentially similar to those observed for K. Reversal of times of sleep (12 noon to 8 p.m.) and daily activity for 13 days in conjunction with constant light resulted in a phase reversal of the circadian pattern of plasma I levels. A similar phase reversal was observed with regard to a.m./p.m. u inary volume ratios. A less definite pattern was noted with regard to the urinary excretion of K. There were two peaks of excretion during the 24-hr period, one occurring during wakefulness (the normal pattern) and the other during sleep. The study indicates that in human subjects, the circadian rise in plasma I (and to a lesser extent the circadian rise in urinary electrolyte levels) is related to processes occurring in the course of sleep and is not dependent on the presence of darkness either in the natural world or in the subject's environment. No information has been obtained with regard to the role of the presence of light in the processes regulating such circadian periodicity. (NRS)

48. KRIEGER, D.T. and F. RIZZO. 1971
Circadian periodicity of plasma 11-hydroxycorticosteroid levels in subjects with partial and absent light perception.
Neuroendocrinology.634:165-179.

Abnormal circadian patterns of plasma corticosteroid levels were observed in three of twelve subjects with total absence of light perception and five of seven subjects with partial absence of light perception secondary to intraocular disease. This abnormality consisted both of elevated levels at given times of day and a lack of reproducibility of the circadian pattern over two successive 24-hr periods. In 11 of 13 subjects with abnormal circadian periodicity, an early morning rise in plasma corticosteroid levels still occurred, though in five of these 11 subjects this rise occurred somewhat in advance of the usual 8 a.m. peak. This might indicate that the sleep-wake rather than dark-light transition plays a major role in the regulation of this phase of circadian periodicity. There was no correlation between the occurrenc of abnormal patterns and either the age of the subject, age at onset or duration of blindness, or the subject's sleep-activity cycle.

49. KRIEGER, D.T. and F. RIZZO 1969
Serotonin mediation of circadian periodicity of plasma 17-hydroxycorticosteroids.
Amer. J. Physiol 217: 1703-1707.

Abolition of the circidian rise of plasma 17-hydroxycorticosteroid levels in the cat was produced by four different types of drugs which alter serotonin levels or action: 3-(2-aminobutyl) indole acetate, which elevates CNS serotonin levels; p-chloramphet-amine, which deplets CNS serotonin levels; 2- (3-dimethylaminopropylthio) cinnamanilide, which acts as a competitive inhibitor of serotonin at the receptor site; and cyproheptadine, which is a serotonin antagonist. L-a-methyl-p-tyrosine, which lowers CNS norepinephrine levels and reserpine, which lowers both CNS serotonin and norepinephrine levels, do not block the circadian rise of plasma 17-hydroxycorticosteroid levels. None of the agents abolishing the circadian rise block; the adrenal response to ACTH the pituitary-adrenal response to lysine vasopressin; the hypothalamic-pituitary-adrenal response to either insulin hypoglycemia or Pseudomonas polysacchraide administration. These data suggest that serotonin plays a role in the nervous pathways mediating circadian periodicity. They also suggest that CNS mechanisms and/or structures involved in the regulation of circadian periodicity of adrenal steroid levels are different from those mediating stress-initiated ad adrenal cortical responses.

50. KRIEGER, D.T. 1970
Factors influencing the circadian periodicity of adrenal steroid levels.
New York Acad. Sc. Trans. 32:316-329

Study of the circadian variation of pituitary-adrenal function and possible mechanisms underlying this periodicity. Experiments are made to ascertain what factors are responsible for the circadian activation of the central nervous system with regard to this periodicity of pituitary-adrenal function. It is shown that circadian periodicity in many variables is a function of age, and that light is the most common and important synchronizing agent for circadian rhythms. The role of light in initiating the level of central nervous system organization required for circadian periodicity is examined in detail. In addition, a more detailed definition is presented of some characteristics of the 'normal' circadian pattern of adrenal steroid levels, especially with regard to the conditions under which it is determined, its reproducibility, and its characteristics obtained by means of greater sampling frequency. (OH)

51. KRIEGER, DOROTHY; WILLIAM ALLEN, FRANK RIZZO, and HOWARD P. KRIEGER. 1971
Characterization of the normal temporal pattern of plasma corticosteroid levels.
J. Clin. Endocrinol. Metab. 32:266-284.

52. LAATIKAINEN, T. and R. VIHKO 1968
Diurnal variation in the concentrations of solvolyzable steroids in human plasma.
J. Clin. Endocrinol. Metab.28:1356-1360.

Plasma samples were obtained from six normal males aged 20-8 years, at 8 a.m., noon, 4 p.m., 8 p.m., midnight, and 8 a.m. the following day. The subjects carried on their usual activities during the test period. The solvolyzable steroids were determined by extn. of the plasma with Me_2CO-EtOH(1:1), followed by chromatography on a 4 g. column of Sephadex LH-20. The monosulfate fraction was eluted with $CHCl_2$-MeOH (1:1) containing a trace of NaCl. The disulfate fraction was eluted with MeOH. The fractions were solvolyzed with EtOAc acidified with H_2SO_4. The solvolyzed steroids were separated by chromotography on a 200 mg. column of silicic acid. Gas-liquid chromatography was used to measure the concentration of the steroids in the eluates. This procedure was specific, accurate, and precise for the detn. of monosulfates of dehydroepiandrosterone (I), androsterone (II), epiandrosterone, and pregnenolone and the mono- and disulfates of androst-5-ene-3β, 17β-diol (III) and pregn-5-ene-3β-20α-diol (IV). The results suggest that a diurnal variation occurs in the concentrations of monosulfated I and II, as well as in that of mono- and disulfated III and IV. The concentrations of these solvolyzable steroids were highest at noon or at 4 p.m. and were 15-30% higher than the lowest values at midnight or at 8 a.m. Apparently the diurnal variation of these sulfated steroids differs from that of plasma 17-hydroxy corticosteroids. (NRS)

53. LEHNERT, G., H.LEIBER, K.H. SCHALLER, 1968
[Plasma corticol of plasma corticosterone in the stage of adaptation to graduated physical labor] (German)
Endokrinologie 52:402-405.

No abstract available.

54. MACINNES, E., R.I. ROTHWELL, H.S. JACOBS, 1971
Plasma-11-hydroxycorticosteroid and growth-hormone levels in climbers.
Lancet 1:49-51.

No abstract available.

55. MIGEON, C.J., F.H. TYLER, J.P. MAHONEY, A.A. FLORENTIN, H. CASTLE, E.L. BLISS and L.T. SAMUELS. 1956
The diurnal variation of plasma levels and urinary excretion of 17-hydroxycorticosteroids in normal subjects, night workers and lind subjects.
J. Clin. Endocrinol. 16:622-633.

56. MILLER, R.G.
Secretion of 17-hydroxycorticosteroids (17-OHCS) in military aviators as an index of response to stress - a review.

Aerosp. Med. 39: 498-501.

Changes in plasma, urinary and parotid fluid 17-hydroxycorticosteroid (17-OHCS) concentrations have been shown to be a useful index for the evaluation of stress. With the development of increasingly effective methods of biomedically monitoring pilots in combat, and the refinement of techniques of analyzing plasma and urinary 17-OHCS, a rapidly accumulating series of studies permits several generalizations regarding the expected physiologic response to stress in combat pilots. Increased adrenal corticosteroid secretion occurs in response to flight factors such as danger, duration of exposure, degree of responsibility and lack of adaptation (experience level). The Vietnam conflict provides a current test situation to further these studies. (Author

57. MORSELLI, P.L., V. MARC, S. GARATTINI and M. ZACCALA. 1970
Metabolism of exogenous cortisol in humans. I. Diurnal variation in plasma disappearance rate.
Biochem. Pharmacol. 19:1643-1647.

No abstract available.

58. NAUMENKO, E.V. and A.G. Starygin. 1970
Seasonal changes in the corticosterone level in the blood of animals kept in groups and in isolation.
[Sezonnye izmeneniia urovnia kortikosterona v krovi pri gruppovom i izolirovannom soderzhanii zhovotnykh]
Akad. Nauk SSSR, Doklady 195: 750-752.

Study of the effect of seasonal factors on the functioning of the adrenal cortex in white rats kept in groups and in isolation. The functioning of the hypophysis-adrenal system was evaluated from the corticosterone content in the peripheral blood as determined fluorometrically. Over a period of a year pronounced seasonal changes in the corticosterone content in the blood were noted both in rats kept in groups and in rats kept in isolation. However, the hypophysis-adrenal system is found to react differently to one and the same complex of seasonal factors, depending on whether the rats were living in groups or in isolation. (ABK)

59. NEPTUNE, E.M. Jr., R.E. DANZIGER, T.L. SALLEE and D.E. UDDIN 1971
Some biochemical determinations on serum from crewmen participating in a 90-day space station simulation test.
In: NASA. Langley Res. Center Prelim. Results from an operational 90-day manned test of a regenerative life support system. p.573-581.

Numerous alterations in the biochemical assays of serum were observed in the crewmen of the space station simulator during and after the 90-day test. These alterations are evaluated in relation to the mean pre-test values with each man serving as his own control. Although the test was judged to be totally benign by the medical staff, the biochemical alterations are tentatively attributed to either the exercise program or the psychological or other stress factors. Final interpretation must await evaluation of these data with the data obtained by other research groups involved in this study. (Author)

60. OYAMA, T. 1970
[Plasma levels of ACTH and cortisol in man during anesthesia and surgery] (Japanese)
Folia Endocrinol. Jap.46:980-981.

No abstract available.

61. PARIN, V.V. et al. 1969
Changes in corticosteroid and catecholamine metabolism after sharp limitation of motor activity
[Izemniya kortikosteroidnogo i katekholaminovogo obmena pri rezkom organizma granichenii dvigatel'noy aktivnosti organizma]
Dokl-Akad. Nauk. SSSR (Moscow)5:250-251.
(NASA-TT-F-12211)

Hypokinesia was induced in sixteen experimental male rabbits and sixteen controls, weighing three to four kg each, by keeping them in cages especially designed to reduce motor activity to a minimum. As the animals lost weight during the experiment the sides of the cages were drawn together to force the animals to remain immobile. The rabbits were sacrificed 11 to 12 and 30 days after the start of the experiment. The contents of oxycorticosteroids in blood plasma and of norepinephrine and epmephrine in the adrenals, myocardium and hypothalamus were determined fluorometrically. Experimental results showed that the sharp limitation of motor activity severely impaired the animals' corticosteroid and catecholamine metabolism. (PAB)

62. RAUD, H.R., C.A. KIDDY and W.D. ODELL. 1971
The effect of stress upon the determination of serum prolactin by radioimmunoassay.
Proc. Soc. Exp. Biol. Med. 136:689-693.

Serum prolactin concentrations were determined by radioimmunoassay during estrus cycles in 15 dairy heifers bled by repeated jugular punctures or from a long, indwelling jugular catheter. The method of bleeding influenced the serum prolactin concentration and was attributed to non-specific stress. Further confirmation for the stress effect was provided by a controlled study on other heifers, submitted to specific forms of acute and chronic stress stimuli. In cattle, studies of blood prolactin concentrations under various physiological conditions may be performed only when environmental conditions are carefully controlled. (PLW)

63. RIMON, R., S. SALONEN and AIMO PEKKARINEN 1968
Antidepressive medication and diurnal variation of plasma 17-OHCS levels in depression.
J. Psychosom. Res. 12:288-295

Diurnal plasma 17-OHCS [17-hydroxycorticosteroid] values were determined for 20 depressed female patients before treatment and after one fortnight and one month of drug therapy. Ten of the patients received monochlorimipramine and the other 10 diazepam. There were no significant differences between the mean diurnal plasma 17-OHCS levels of the two patient groups either in the pre-treatment phase or after introducing the drug therapy. The diurnal plasma 17-OHCS values were higher in all depressive patients in the pre-treatment phase than in nonhospitalized health medical personnel (p 0.05). This is concluded to be due not to the depressive illness itself but rather reflects the adrenocortical response of the patients to admission to a psychiatric clinic. Patients with good remission did not have higher 17-OHCS values than patients with poor remission before drug therapy was initiated. After one month's treatment the values of the good remission group were higher, but only where levels at 9.00 p.m. were compared was the difference statistically significant (p 0.05). This is believed to be due to the greater chronic neuroticism in the depressive patients with poor remission. (Authors)

64. ROSE, L.I., H.S. FRIEDMAN, S.C. BEERING 1970
Plasma cortisol changes following a mile run in conditioned subjects.
J. Clin. Endocr. 31:339-341.

No abstract available.

65. RUBIN, R.T., R.G. MILLER, R.J. ARTHUR 1970
Differential adrenocortical stress responses in naval aviators during aircraft carrier landing practice.
Psychol. Rep. 26:71-74.

No abstract available.

66. RUBIN, R.T., E.J. KOLLAR, G.G. SLATER 1970
Excretion of 17-hydroxycorticosteroids and vanillylmandelic acid during 205 hours of sleep deprivation in man.
Psychosom. Med. 31:68-79.

No abstract available.

67. RUBIN, R.T., R.H. RAHE, B.R. CLARK, 1970
Serum uric acid, cholesterol, and corticol levels. Inter-relationships in normal men under stress.
Arch. Intern. Med. 125;815-819.

No abstract available.

68. SCAPAGNINI, U., G.P. MOBERG, G.R. VAN LOON, J. DE GROOT and W.F. GANONG.1971
Neuroion of brain 5-hydroxytryptamine content to the diurnal variation in plasma corticosterone in the rat.
Neuroendocrinology, 7:90-96.

In adult male rats, the 5-HT [5-hydroxytryptamine] content of the hippocampus and the amygdala exhibited a diurnal rhythm, with the lowest value at 0400 and the highest at 2000 hr. The diurnal curve of plasma corticosterone generally parallels the 5 HT content with the lowest value at 0800 and the highest at 2000 hr. p-chlorophenylalanine [PCPA], 300 mg/kg 72 and 48 hr before sacrifice, increased the a.m. and decreased the p.m. plasma corticosterone values, so that the level remained relatively constant throughout the day. At both 0800 and 2000 hr. the PCPA produced a 50-63% reduction in the 5-HT content of the amygdala, hippocampus, and hypothalamus. The results suggest that serotoninergic neurons play a role in the diurnal fluctuation in pituitary adrenal function (PLW)

69. SCHONBERGER, A., W. WALDMANN 1970
[The effect of tooth extraction and local anesthesia on human pulse frequency, blood pressure and plasma hydrocorticoid level] German
Deutsch zahn mund kieferheilk 54:241-248.

No abstract available.

70. SCLARE, A.B., and J.K. GRANT 1969
Plasma 11-hydroxycorticosteroid concentration in depressive illness.
J. Endocrinol. 43:677-678.

In 18 patients 22-73 years old with endogenous or reactive types of depression, plasma concentrations of 11-hydroxycorticosteroids were determined, in blood taken at 9 a.m. and 9 p.m. Concentrations were all highest in the morning except for three reversals. Comparable controls all had higher morning values. In 14 patients serial weekly determinations showed higher levels than controls both morning and night with greater morning-night differences. Severity of depression was not correlated with levels. Night values were higher in cases of endogenous depression than in reactive depression. (KK)

71. SMITH, G.P. and A.W. ROOT 1971
Dissociation of changes in growth hormone and adrenocortical hormone levels during brain stimulation of monkeys.
Neuroendocrinology, 8:235-244

Plasma concentrations of immunoreactive growth hormone (GH) and of 17-hydroxycorticosteroids (17 OHCS) were measured during electrical stimulation of hypothalamus or hippocampus in six conscious monkeys adapted to chronic restraint in primate chairs. Plasma GH and 16-OHCS increased during 13 14 hypothalanine stimulation experiments. During hippocampal stimulation, however, chances of plasma GH and 17-OHCS were variable, in 6 of 12 hippocampal experiments the qualitative change of plasma 17-OHCS differed from that of GH. These dissociated hormonal changes during hippocampal stimulation are evidence that the central neurological control systems for GH and ACTH are functionally distinct. When the GH and 17-OHCS changes were correlated with the vehavior elicited by brain stimulation rather than with the site of stimulation, peak increases of GH but not of 17 OHCS were significantly greater during behavior characterized by pupillary dilatation or vigorous attempts to escape from the primate chair than during simple 'alerting' vehavior. This suggests that plasma GH may reflect the intensity of the central excitatory state better than plasma 17 OHCS.

72. SOLEM, J.H. 1970
[Stress - theory and practice] (Norwegian)
Tidsskr nor Laegeforen 90:1996-2000.

No abstract available.

73. SUWA, N., I. YAMASHITA, 1970
[Neuroendocrinological studies of mental disorders] (Japanese)
Saishin Igaku. 25:2090-2097.

No abstract available.

74. TREIMAN, D.M. and S. LEVINE, 1969
Plasma corticosteroid response to stress in four species of wild mice.
Endocrinology 84:676-680.

No abstract available.

75. UOZOMI, T., H. TANAKA, Y. HAMANAKA 1968
[Dynamics of steroid hormones during surgical stress] (Japanese
Jap. J. Clun. Med. 26;1999-2007.

No abstract available.

76. VERNIKOS-DANELLIS, J., C.M. WINGET and N.W. HETHERINGTON, 1970
Diurnal rhythm of the pituitary-adrenocortical response to stress. Effect of constant light and constant darkness.
Life Sciences and Saace Research VIII:240-246.

No abstract available.

77. WALLNER, E., M. KEREPESI and M. RADNOT. 1966
The effect of light on the ketosteroid excretion.
Transl. into English from Acta Chir. (Hungary)4:181-183

The day-night rhythmicity of ketosteroid excretion was studied in hospitalized patients, as well as the effect of light or the influence of the temporary elimination of light on the extent and the rhythm of the ketosteroid excretion. The 12-hr night fraction proved to be 30.5% less than the same fraction taken during the day. Complete darkness lasting from 7 - 10 days reduced the mean value of the excreted ketosteroids, although the day-night rhythm persisted.

78. WEGMANN, H.M., K.E. KLEIN, and H. BRUNER 1967
The effect of flight stresses on several blood components
[Die auswirkung flingerischer belastung auf einige blutkomponenten]
Int. Zeit Physio. Arb. 23: 273-364.

Determination of the physiological effects of flight stress in jet pilots who fly the Starfighter F 104G. Stress reactions to flying evaluated by blood determinations including ATP, blood sugar, ascorbic acid, the free 11-hydroxycorticosteroids and the activities of four cell enzymes. The following conclusions are presented (1) flying this aircraft caused significant responses of most parameters; (2) relations were found between the responses and th stress intensity; and (3) in some cases flying the aircraft caused stress values which were no longer within the normal clinical range.(RBS)

79. YAMASHITA, I. 1970
[Psychoendocrinological study of emotion in clinical practice, with special reference to circadian rhythm and stress reaction of blood adrenocortical hormone level] (Japanese)
Advances Neurol. Sci. (Tokyo) 14:195-202

No abstract available.

80. ZURBRUEGG, P. and J. NOREN 1968.
Circadian rhythm of plasma cortisol under changed environmental conditions.
[Plasmacortisol-Tagesrhythmus unter veranderten Umweltbedingungen].
Schequzerische Med. Wochenschrift (Basel)98:724.

The effects of a one-time change in time zone and repeated changes in work shift on the circadian rhythm of plasma cortisol was investigated. A one-time change in time zone from American to Europe or vice versa produced on the one hand, short-duration changes in rhythm, such as frequency increase and a shift in the plane of oscillation to a higher level; on the other hand, the original work rhythm remained effective for several months as a supplemental timing device and led to a long-term change in rhythm, in competition with the new environmental factors. Similar cyclic disturbances were caused by repeated changes in work shift for the maintenance staff. In contrast to the observations during a time zone change, these oscillations could not be brought into meaningful synchronization with the newly effective work rhythms. Such working conditions obviously lead to a far-reaching and unusually sustained desynchronization. As a result, our chosen experimental conditions produced the most severe rhythm disturbances continuously over several months. Some of these oscillation patterns reminded us of those observed in babies and infants. (TPU)

DATA PROCESSING OF BIOLOGICAL RHYTHMS

Computer techniques for determining frequency, phase and entrainment of biological rhythms are included. Methods for analyzing biological rhythm data as well as mathematical models of various living systems are represented in this search.

1. ADEY, W.R. and D.O. WALTER.
Application phase detection and averaging techniques in computer analysis of EEG records in the cat.
Exptl. Neurol. 7:186-209.

2. ANDREWS, R.V. and G.E. FOLK, JR. 1964.
Circadian metabolic patterns in cultured hamster adrenal glands.
Comp. Biochem. Physiol. 11:393.

3. ANDERSON, J.A. 1964.
Thermovariance spectra in children.
Ann. N.Y. Acad. Sci. 117(1):354.

4. ASANO, M., K. YOSHIDA, K. YAIDA, and S. KOBAYASHI. 1968.
In vivo observation of the behavior of microcirculation by the rabbit ear chamber technique: 3. Frequency analysis of the spontaneous rhythmic fluctuations observed in the microcirculation.
Bull. Inst. Pub. Health 17(3):219-226.

5. ASCHOFF, J. 1964.
Biological periodicity as a self stimulated oscillation.
Veroffentlichungen Arb Forsch Landes Nord-Westfalen Natur-Ing Gesellschaftswiss 138:51-101.

6. ASCHOFF, J. 1961.
Biologische Uhren.
In: B.C. Christensen and B. Buchmann, editors. Progress in Photobiology. Amsterdam, Elsevier. P. 50.

7. ASCHOFF, J. 1960.
Exogenous and endogenous components in circadian rhythms.
In: L. Frisch and A. Chownik, editors. Biological Clocks, New York, C.S.H. Symp. Quant. Biol. P. 11.

8. AULENBROCK, J.C. 1969.
Cyclic modes in neural net models.
Bull Math Biophys. 31:505-17.

9. BAILLAUD, L. and Y. COURTOT. 1962.
Observations sur le Rhythme de la Ramification du Chamaecyparis nootkatenis.
In: G. Dell'Acqua, A. Jores, A. Canniggia and A. Sollberger, editors. Rep. 7th Internat. Conf. Soc. Biol. Rhythm. Turin, Panminerva Medica. P. 7.

10. BALAKHOVSKII, I.S. 1966.
The development of Venkebach-Samoilov cycles in continuous and quasi-continuous models.
Biofizika. 11(1):129-133.

11. BANGERT, H. 1960.
Untersuchungen zur Koordination der Kopf-und Beingewegungen beim Haushuhn.
Z. Tierpsychol. 17(2):143.

12. BARLOW, J.S. 1967.
Correlation analysis of EEG-tremor relationships in man.
Electroencephalography and Clinical Neurophysiology. 25: 167-77.

13. BARRETT, J.C. 1966.
A mathematical model of the mitotic cycle and its application to the interpretation of percentage labeled mitoses data.
J. Nat. Cancer Inst. 37(4):443-450.

14. BARTON, D.E., F.N. DAVID, and E. FIX. 1963.
Random points in a circle and the analysis of chromosome patterns.
Biometrika 50(1/2).

15. BENDAT, J.S. 1961.
Interpretation and application of statistical analysis for random physical phenomena.
Lecture Univ. Calif. Med. Center.

16. BHARGAVA, T.N. 1963.
A stochastic model for animal behavior in time.
Biometrics 19(4):656-657.

17. BLOCK, J.D. and W.H. BRIDGER. 1962.
The law of initial value in psychophysiology: A reformation in terms of experimental and theoretical considerations.
Ann. N.Y. Acad. Sci. 98:1229-1241.

18. BOSCH, A.v.d., E.I. SCHLINGER, and K.S. HAGEN. 1962.
Initial field observations in California on Trionyspallidus.
J. Econ. Entomol. 55(6):857.

19. BOYARSKY, L.L. 1967.
Neural net analogs of rhythmic activity in the nervous system.
Curr. Mod. Biol. 1(1):39-46.

20. BRAINES, S.N. and V.B. SCECHINSKII. 1968.
Problems of neurocybernitics and neurobionics.
Moscow, Izdatel'stvo Meditsina. 232 pages.

21. BRANDT, E.N., Jr. 1962.
Gastric secretion and the law of initial value.
Ann. N.Y. Acad. Sci. 98:1291-95.

22. BRANION, R.M.R., B.F.J. CADDICK, and W.B. McCONNELL. 1967.
A mathematical analysis of the combined tricarboxylic-acid-glyoxylate cycles.
Can. J. Biochem. 45(6):863-72.

23. BROWN, F.A. Jr. 1960.
Response to pervasive geophysical factors and the biological clock problem.
In: L. Frisch and A. Chownik, editors. Biological Clocks.
New York, C.S.H. Symp. Quant. Biol. P. 57.

24. CHANCE, B., J.J. HIGGINS, and D. GARFINKEL. 1962.
Analogue and digital computer representations of biochemical processes.
Fed. Proc. 21:75-86.

25. CHANCE, B., B. SCHOENER, and S. ELSAESSER. 1964.
Control of the waveform of oscillations of the reduced pyridine nucleotide level in a cell-free extract.
Proc. Nat. Acad. Sci. USA 52(2):337-41.

26. CHANCE, B., K. PYE, and J. HIGGINS. 1967.
Waveform generation by enzymatic oscillators.
IEEE Spectrum 4:79-86.

27. CLYNES, M. 1962.
The non-linear dynamics of unidirectional rate sensitivity illustrated by analog computer analysis, pupillary reflex to light and sound, and heart rate behavior.
Ann. N.Y. Acad. Sci. 98(4):806-45.

28. DAS, B.C. 1963.
Age-specific probability distributions of annual mortality.
Gerontologia (Basel) 8(1):46-57.

29. DESJARDINS, R.L. 1967.
Time series analysis in agrometeorological problems with emphasis on spectrum analysis.
Can. J. Plant Sci. 47:477-91.

30. DICKINSON, C.J. 1969.
A digital computer model of the effects of gravitational stress upon the heart and venous system.
Med. Biol. Engin 7:267-75.

31. EHRET, C.F. and E. TRUCCO. 1967.
Molecular models for the circadian clock. I. The chronon concept.
J. Theor. Biol. 15:240-62.

32. EHRET, C.F. and J.S. BARLOW. 1960.
Toward a realistic model of a biological period-measuring mechanism.
Cold Spring Harbor Symposia on Quantitative Biology. 25: 217-220.

33. ELSTON, R.C. and J.E. GRIZZLE. 1962.
Estimation of time-response curves and their confidence bands.
Biometrics 18(2):148-59.

34. ELSTON, R.C. 1962.
Note: On estimating time-response curves.
Biometrics 20(3):643-47.

35. ENGELI, M. and F. HALBERG. 1964.
Spectral analysis of steroid rhythms in data at equal or unequal intervals.
Fed. Proc. 23:250.

36. ENRIGHT, J.T. 1965.
The search for rhythmicity in biological time-series.
J. Theoret. Biol. 8:426-468.

37. ESSLER, W.O. and G.E. FOLK, Jr. 1961.
Determination of physiological rhythms of unrestrained animals by radio telemetry.
Nature 190(4770):90.

38. FOLK, G.E., Jr. 1962.
Observations on the daily rhythms of body temperature-labile mammals.
Ann. N.Y. Acad. Sci. 98(4):954,

39. GADERMANN, E., G. HILDEBRANDT, and H. JUNGMAN. 1961.
Ueber harmonische Beziehungen zwischen Pulsrhythmus und arterieller Grundschwingung.
Z. Kreislaufforsch. 50:805.

40. GALICICH, J.H., E. HAUS, F. HALBERG, and L.A. FRENCH. 1964.
Variance spectra of corticosteroid in adrenal venous effluent of anesthetized dogs.
Annals. of N.Y. Acad. of Sci. 117:281-91.

41. GANDER, J.E. 1967.
Some possible interrelationships between steady-state kinetics and time.
Ann. of the N.Y. Acad. of Sci. 138:730

42. GARCIA-SAINZ, M. and F. HALBERG. 1966.
Mitotic rhythms in human cancer, reevaluated by electronic computer programs--Evidence for chronopathology.
J. Nat. Cancer Inst. 37(3):279-92.

43. GIBSON, R.J., R.M. GOODMAN, and A. MARMAROU. 1965.
A bio-instrumentation system for circadian rhythm studies.
In: Digest of the Sixth International Conference on Medical Electronics and Biological Engineering, P. 222-223. (Tokyo)

44. GOODWIN, B.C. 1966.
An entrainment model for timed enzyme syntheses in bacteria.
Nature (London) 209(5022):479-81.

45. GOODMAN, L. 1962.
On the dynamics of pulmonary ventilation in quiescent man.
Thesis. Case Inst. Techn. Ohio.

46. GRODINS, F.S., et al. 1970.
General formulation of the cardiovascular control problem--mathematical models of the mechanical system.
Behav. Sci. 15:88-100.

47. GUREVICH, B.Kh., and I.V. MEDVEDEVA. 1969.
Triggering timing and "biological clock" characteristics in response to single critical night action in photoperiodism.
Biofizika 14(1):173-78.

48. HALBERG, F. 1961.
Application of general harmonic analysis to circadian systems.
In: S.J. Fomom, editor. Circadian Systems. Ohio, Rep. 39th Ross Conf. Ped. Res., Ross Lab. , p. 23.

49. HALBERG, F. 1969.
Chronobiology.
Ann. Rev. Physiol. 31:675-725.

50. HALBERG, F. and H. SIMPSON. 1967.
Circadian acrophases of human 17-hydroxycorticosteroid excretion referred to midsleep rather than midnight.
Human Biology 39:405-12.

51. HALBERG, F., Y.L. TONG, and E.A. JOHNSON. 1967.
Circadian system phase - an aspect of temporal morphology - procedures and illustrative examples.
In: The Cellular Aspects of Biorhythms; International Congress of Anatomy, 8th, Symposium on Rhythmic Research, Wiesbaden, West Germany, August 8-14. P. 19-48.

52. HALBERG, F., M. DIFFLEY, M. STEIN, H. PANOFSKY, and G. ADKINS. 1964.
Computer techniques in the study of biologic rhythms.
Ann. N.Y. Acad. Sci. 115:695-720.

53. HALBERG, F., R. ENGEL, R. SWANK, G. SEAMAN, and W. HISSEN. 1966.
Cosinor analysis of circadian rhythms of small amplitude in the human blood.
Physikalische Medizin und Rehabilitation 7(5):101-7.

54. HALBERG, F., R. LOEWENSON, R. WINTER, J. BEARMAN, and G.H. ADKINS. 1960.
Differences in period of circadian rhythms or in their component frequencies.
Proc. Minn. Acad. Sci. 28:53.

55. HALBERG, F. and C. HAMBURGER. 1965.
Electronic computer techniques for the study of endocrine rhythms.
Acta Endocrin. (Copenhagen) 100:170.

56. HALBERG, F. and E. HAUS. 1962.
Frequency structure of human metabolism resolved by variance spectra.
In: Proc. 22nd Internat. Physiol. Congr. 2(456).

57. HALBERG, F. 1960.
The 24-hour scale; a time dimension of adaptive functional organization.
Persp. Biol. Med. 3:491.

58. HALBERG, F., C. VALLBONA, L.F. DIETLEIN, J.A. RUMMEL, C.A. BERRY, G.C. PITTS, and S.A. NUNNELY. 1970.
Human circadian circulatory rhythms during weightlessness in extraterrestrial flight or bedrest with and without exercise.
Space Life Sci. 2:18-32.

59. HALBERG, F., H. PANOFSKY, and H. MANTIS. 1964.
Human thermo-variance spectra.
Ann. N.Y. Acad. Sci. 117:254-274.

60. HALBERG, F. 1964.
Organisms as circadian systems; temporal analysis of their physiologic and pathologic responses, including injury and death.
In: Symposium on Medical Aspects of Stress in the Military Climate. April 22-24.

61. HALBERG, F. 1963.
Periodicity analysis - a potential tool for biometeorologists.
Internat. J. Biometeorol. 7(2):167-91.

62. HALBERG, F., G. ADKINS, and E. MARTE. 1962.
Reserpine effect upon the variance spectrum of human rectal temperature.
Fed. Proc. 21:347.

63. HALBERG, F. 1966.
Resolving power of electronic computers in chronopathology. An analogy to microscopy.
Scientia. 101:412-19.

64. HALBERG, F. 1967.
Rhythmic interactions of steroidal and neural functions.
In: L. Martini, F. Fraschini and M. Motta, editors. Hormonal Steroids, p. 966-79. Amsterdam, Excerpta Med. Found.

65. HALBERG, F. 1964.
Some aspects of biologic data analysis: longitudinal and transverse profiles of rhythms.
In: J. Aschoff, ed. Circadian Clocks. Proceedings of the Feldafing Summer School, Amsterdam, North-Holland Publ. Co, p. 13-22.

66. HALBERG, F. 1960.
Some current research methods and results with special reference to the central nervous system. II. Physiopathologic approach.
Am. J. Mental Def. 65:156-71.

67. HALBERG, F. 1960.
Temporal coordination of physiologic function.
In: L. Frisch and A. Chownik, editors. Biological Clocks. New York, C.S.H. Symp. Quant. Biol. P. 289.

68. HALBERG, F. and H. PANOFSKY. 1961.
I. Thermo-variance spectra: Method and clinical illustrations.
Exp. Med. Surg. 19:284-309.

69. HALBERG, F. and C. FALLIERS. 1966.
Variability of physiologic circadian crests in groups of children studied "transversely".
The Journal of Pediatrics 68(5):741-46.

70. HARDING, G., P.M. JEAVONS, F.A. JENNER, P. DRUMMOND, M. SHERIDAN, and G.W. HOWELLS. 1966.
The electroencephalogram in three cases of periodic psychosis.
Electroenceph. Clin. Neurophysiol. 21:59-66.

71. HAUS, E. and F. HALBERG. 1967.
Circadian acrophases of human eosinophil rhythm in patients with progressive or remitting rheumatoid arthritis, as compared to patients with osteoarthritis and healthy subjects.
Rass. Neurol. Veg. 21:227-34.

72. HAUS, E. and F. HALBERG. 1966.
Circadian phase diagrams of oral temperature and urinary functions in a healthy man studied longitudinally.
Acta Endocrinologica 51:215-23.

73. HAUS, E., D. LAKATUA, and F. HALBERG. 1967.
The internal timing of several circadian rhythms in the blinded mouse.
Exptl. Med. Surg. 25:7-45.

74. HAUS, E. 1964.
Periodicity in response and susceptibility to environmental stimuli.
Ann. N.Y. Acad. Sci. 117(1):292-319.

75. HAVILL, B.G., J.E. PEARSON, and S.A. SELF. 1960.
Programming circular autocorrelation for cycle research.
J. Cycle Res. 9(3):117.

76. HAWKING, F. 1962.
Microfilaria infestation as an instance of periodic phenomena seen in host-parasite relationship.
Ann. N.Y. Acad. Sci. 98(4):940.

77. HEATH, H.A. and D. OKEN. 1962.
Change scores as related to initial and final values.
Ann. N.Y. Acad. Sci. 98:1242-56.

78. HELLBRUGGE, T., J. PECHSTEIN, R. ULLNER, and K. REINDL. 1967.
A review of periodicity analysis in medicine.
Fortschr. Med. 85(7):289-95.

79. HIGGINS, J. 1967.
The theory of oscillating reactions.
Indust. Engin. Chem. 59(5):18-62.

80. HILDEBRANDT, G., and K. GEHLKEN. 1961.
Aktuelle probleme der balneologie.
Arztl. Forsch. 15(2):76.

81. HILDEBRANDT, G. 1961.
Balneologie und rhythmusforschung.
Allg. Therap. 6-7.

82. HOFFMANN, K. 1963.
On the relation between the phase angle and the spontaneous frequency in endogenous diurnal periodicity.
Zeit. Naturforsch. 18b(2):154-57.

83. HOSHIZAKI, T., and K.C. HAMNER. 1969.
Computer analysis of the leaf movements of Pinto beans.
Plant Physiol. 44(7):1045-50.

84. HURWICZ, L. 1962.
Basic mathematical and statistical considerations in the study of rhythms and near-rhythms.
Ann. N.Y. Acad. Sci. 98:851-57.

85. JEHLE, H. 1969.
Charge fluctuation forces in biological systems.
Ann. NY. Acad. Sci. 158(1):240-55.

86. JEREBZOFF, S., and E. LAMBERT. 1967.
Detection by the variance spectrym method of two rhythms simultaneously controlling the sporulation of Myrothecium verrucaria (Alb. and Schw.).
Compt. Rend. Acad. Sci. Paris 262 Ser. D:322-25.

87. KAISER, I.H. and F. HALBERG. 1962.
Circadian periodic aspects of birth.
Ann. N.Y. Acad. Sci. 98:1056-68.

88. KALMUS, H. and L.A. WIGGLESWORTH. 1960.
Shock excited systems as models for biological rhythms.
Cold Spring Harbor Symposia on Quantitative Biology.
25:211-16.

89. KARVE, A.D., et al. 1965.
A feedback model to demonstrate the phenomenon of photoperiodic entrainment of circadian oscillations.
Naturwissenschaften 52:664-65.

90. KARVE, A.D. 1963.
A theoretical study of the circadian rhythmical phenomena in biology.
Res. Bull. Panjab. Univ. Sci. 14(1/2):49-57.

91. KLINKER, L. and W. LEIDREITER. 1969.
Model representation of the regulatory principles of the human organism. II. Diurnal and seasonal variations of mortality due to cardiac and circulatory failure.
Zeitschrift fur Meteorologie 21(3-4):88-93.

92. KLOTTER, K. 1960.
General properties of oscillating systems.
Cold Spring Harbor Symposia on Quantitative Biology. 25:185-7.

93. KLOTTER, K. 1960.
Theoretical analysis of some biological models.
Cold Spring Harbor Symposia on Quantitative Biology. 25: 189-96.

94. KO, W., O. LINDAN, and J.B. RESWICK. 1965.
Implant transducers and biological rhythms - on earth and in space.
Advances in the Astronautical Sciences. 19:289-310.

95. KOEPCHEN, H.P. 1962.
Ueber das Zusammenwirken endogener Rhythmik und reflektorischer Tonisierung bei der nervosen Steuerbung der Herzfrequenz.
In: G. Dell'Acqua, A. Jores, A. Canniggia and A. Sollberger, editors. Atti VI Conf. Intern. Soc. Stud. Ritm. Biol. Turin, Panminerva Medica. P. 94.

96. KOEPCHEN, H.P., P. hH. WAGNER, and H.P. LUX. 1961.
Ueber die Zusammenhaenge zwischen zentraler Erregbarkeit, reflektorischem Tonus und Atemrhythmus bei der nervosen Steuerung der Herzfrequenz.
Pflueger's Arch. 273:443.

97. KOREIN, J, L.J. TICK, R.J. ZEITLIN, and C.T. RANDT. 1968.
Linear and nonlinear spectral analytic techniques applied to the human electroencephalogram.
Bull. N.Y. Acad. Med. 44(9):1126-28.

98. KRESCH, E., et al. 1969.
A mathematical model for the pressure-flow relationship in a segment of vein.
IEEE Trans. Blomed Engin. 16:296-307.

99. KRETSCHMER, W. 1963.
The rhythm problem in psychiatry.
Prensa Med. Mex. 28:134-39.

100. KRUGER, F. 1961.
On the exponents of the temperature function of biological events and the magnitude of their dependence.
Biol. Zentralbl. 80(6):721-50.

101. KUENKEL, H. 1963.
Autokorrelationsfunktion und harmonische Analyse beim Studium paroxysmaler Phaenomene im Elektroencephalogramm.
8th Conf., Hamburg, Germany, Sept. 9-11. Society of Biological Rhythms.

102. KUNKEL, H. 1968.
Modern analysis of periodic events in neurology.
Deutsches Medizinsches Journal 19(9):319-27.

103. LACEY, J.I., and B.C. LACEY. 1962.
The law of initial value in the longitudinal study of autonomic constitution: Reproducibility of autonomic responses and response patterns over a four-year interval.
Ann. N.Y. Acad. Sci. 98:1257-90.

104. LAKATUA, D. 1964.
Analysis of estrus smears by variance spectra.
Annals of N.Y. Acad. of Sci. 117:275-80.

105. LAMPRECHT, G. and F. WEBER. 1970.
A new method for calculating the period lengths of rhythmical physiological processes.
Pflugers Archiv. 315(3):262-72.

106. LANNI, F. 1961.
Analysis of sequence patterns in ribonuclease, II. Primitive groups, their coordinations, and periodicity.
Proc. Natl. Acad. Sci. USA 47(3):261-70.

107. LEONG, Y.S. 1962.
The use of an iterated moving average in measuring seasonal variations.
J. Am. Stat. Assoc. 297:149.

108. LINDSAY, H.A. and V.S. KULLMAN. 1966.
Pentobarbital sodium: Variation in toxicity.
Science 151(3710):576-77.

109. LOHMANN, M. 1966.
Errors in the calculation of phase shifts due to a simultaneous change in the circadian frequency.
Experientia XXII, 15:340-42.

110. LOWE, C.H., D.S. HINDS, P.J. LARDNER, and K.E. JUSTICE. 1967.
Natural free-running period in vertebrate animal populations.
Science 156:531-34.

111. MATSUMOTO, H., Y. SAIGUSA, and H. AKAIKE. 1962.
Analytical studies on fluctuations of daily milk yield detected by the procedure of harmonic analysis.
Natl. Inst. Animal Health Quart. 2(3):161-71.

112. MCHUGH, R.B. and F.J. WALL. 1962.
Estimating the precision of time period effects in longitudinal models with serially correlated and heterogenous errors.
Biometrics 18(4):520.

113. MENAKER, M. 1969.
Biological clocks.
BioScience 19:681-89, 692.

114. MENZEL, W. 1962.
Periodicity in urinary excretion in healthy and nephropathic persons.
Ann. N.Y. Acad. Sci. 98(4):1007.

115. MENZEL, W. 1962.
Ueber latente Perioden.
In: G. Dell'Acqua, A. Jores, A. Canniggia and A. Sollberger, editors. Rep. 7th Internat. Conf. Soc. Biol. Rhythm. Turin, Panminerva Medica. P. 112.

116. MERCER, D.M.A. 1960.
Analytical methods for the study of periodic phenomena obscured by random fluctuations.
Cold Spring Harbor Symposia on Quantitative Biology. 25: 73-86.

117. MILES, G.H. 1962.
Telemetering techniques for periodicity studies.
Ann. N.Y. Acad. Sci. 98(4):858.

118. MILSUM, J.H. 1969.
Optimization aspects in biological control theory.
In: Advances in Biomedical Engineering and Medical Physics Volume 1. Edited by S.N. Levine. New York, Interscience Publishers, p. 243-78.

119. MOCK, D.C., Jr. 1962.
The effects of the law of initial value on drug-induced diuresis.
Ann. N.Y. Acad. Sci. 98:1296-1301.

120. MOSHKOV, B.S. and L. Ya. FUKSHANSKII. 1966.
Construction of a mathematical model of "biological clocks" of higher plants.
Biofizika 11(3):518-23.

121. MOSHKOV, B.S., S.L. PUMPYANSKAYA, and L.Ya. FUKSHANSKII. 1969.
Some qualitative results of an analysis of a photoperiodism model.
Fiziol. Rast. 16(1):41-48.

122. NIN, C., J.E. DUBRA, M.C. MASTRASCUSI, M.A. DE BAYARRES, and A.J. REYES. 1968.
Formal biomathematical and physiological study of the effects of bilateral compression of the primary carotids on arterial pressure and on the heart rate of normal adults.
Arq. Brasil. Cardiol. 21(5):301-10.

123. PARIN, V.V., and E.B. SHULZHENKO. 1969.
Applying the principles of physiological modeling in space biology and medicine.
Aerospace Medicine 40:242-44.

124. PARIN, V.V. 1968.
Principles of medical control during long-term spaceflights.
Space Biol. and Med. 2(4):99-102.

125. PAVLIDIS, T. 1967.
A mathematical model for the light affected system in the Drosophila eclosion rhythm.
Bull. Math. Biophys. 29(2):291-310.

126. PAVLIDIS, T., W.F. ZIMMERMAN, and J. OSBORN. 1968.
A mathematical model for the temperature effects on circadian rhythms.
Journal of Theoretical Biology 18:210-21.

127. PAVLIDIS, T. 1967.
A model for circadian clocks.
Bull. Math. Biophys. 29(4):781-91.

128. PAVLIDIS, T. 1969.
An explanation of the oscillatory free-rums in circadian rhythms.
Amer. Natur. 103(929):31-42.

129. PAVLIDIS, T. and W. KAUZMANN. 1969.
Toward a quantitative biochemical model for circadian oscillators.
Arch. Biochem. Biophys. 132(1):338-348.

130. PANOFSKY, H. and F. HALBERG. 1964.
The concomitant evaluation of circadian and menstrual components in the variance spectrum of body temperatures.
Ann. N.Y. Acad. Sci. 117(1):1.

131. PECKHAM, R.H. and W.M. HART. 1961.
The geometrical analysis of the photopic corneal ERG. I. ON- and OFF-responses.
Exptl. Eye Res. 1(1):5-13.

132. POSNER, C.J. and D.A. BERMAN. 1969.
Mathematical analysis of oscillatory and non-oscillatory recovery of contractility after a rested-state contraction and its modification by calcium.
Circ. Res. 25(6):725-33.

133. PUTKONEN, P.T.S., H.S.S. SARAJAS, and D. STENBERG. 1969.
Computer analysis of hippocampal rhythm in hypothermic rabbits.
Ann. Med. Exp. Biol. Fenn. 46(4):552-56.

134. RASHEVSKY, N. 1969.
Mathematical theory of biological periodicities: II. Effect of active transport.
Bull. Math. Biophys. 31(3):591-603.

135. RASHEVSKY, N. 1968.
Mathematical theory of biological periodicities: Formulation of the n-body case.
Bull. Math. Biophys. 30(4):735-49.

136. RASHEVSKY, N. 1967.
Mathematical theory of the possible role of intercellular fluid and of vascularization on physiological periodicities.
Bull. Math. Biophys. 29(2):395-401.

137. RASHEVSKY, N. 1968.
A suggestion of a new approach to the theory of some biological periodities (mathematical models).
Bull. Math. Biophys. 30(4):751-60.

138. REINBERG, A., Z.W. ZAGULA-MALLY, J. GHATA, and F. HALBERG. 1967.
Circadian rhythm in duration of salicylate excretion referred to phase of excretory rhythms and routine.
Proc. Soc. Exptl. Biol. Med. 124:826-832.

139. REINBERG, A. 1967.
The hours of changing responsiveness or susceptibility.
Perspect. Biol. Med. 11(1):111-128.

140. RICHARDS, A.G. and F. HALBERG. 1964.
Oxygen uptake rhythms in a cockroach gauged by variance spectra.
Experientia 20(1):40-42.

141. RIDEOUT, V.C. 1969.
Computer simulation of physiological processes.
In: Computational Approaches in Applied Mechanics; American Society of Mechanical Engineers, Computer Conference, Illinois Institute of Technology, Chicago, Ill. New York, American Society of Mechanical Engineers, p. 230-241.

142. ROBERTS, S.K. DE F. 1960.
Circadian activity rhythms in cockroaches I.
J. Cell. Comp. Physiol. 55(1):99.

143. SAGE, A.P. et al. 1962.
Study and research on electronic simulation of the biological clock.
Final report. Wright-Patterson AFB, Ohio, 18 pages.

144. SAVAGE, I.R., M.M. RAO, and F. HALBERG. 1962.
Test of peak values in physiopathologic time series.
Exp. Med. and Surg. 20:309.

145. SCHECHTER, M.S., S.R. DUTKY, and W.N. SULLIVAN. 1963.
Recording circadian rhythms of the cockroach with a capacity-sensing devise.
J. Econ. Entomol. 56:1.

146. SCHEICH, H. 1969.
The behavior of alpha rhythm under defined motor and pharmacological conditions.
Electroenceph. Clin. Neurophysiol. 27:626.

147. SCHERRER, H. 1962.
Effect of basal blood pressure levels on blood pressure responses to central nervous stimulation.
Ann. N.Y. Acad. Sci. 98:1302-15.

148. SCHLECHTE, F.R. 1966.
Parameter selection for periodicity measurement by the method of power spectral analysis.
In: Neural Control of Hibernation in Mammals: the Relevance of Physiol Clocks and Environ. Factors. P. 3-11.

149. SCHMITT, O.H. 1962.
Adaptive analog models for biological rhythms.
Ann. N.Y. Acad. Sci. 98(4):846-50.

150. SCHMITT, O.H. 1960.
Biophysical and mathematical models of circadian rhythms.
Cold Spring Harbor Symposium Quantitative Biology 25:207.

151. SCHNEPS-SHNEPPE, M.A. 1968.
A mathematical model of the generation of rhythm in the sinoatrial node of the heart.
Vestn. Akad. Med. Nauk. SSSR 23:37-40.

152. SELBACH, H. 1962.
The principle of relaxation oscillation as a special instance of the law of initial value in cybernetic functions.
Ann. N.Y. Acad. Sci. 98:1221-28.

153. SIMBORG, D.W., R.S. ROSS, and K.B. LEWIS. 1966.
The R-R interval histogram. A technique for the study of cardiac rhythms.
J. Amer. Med. Ass. 197(11):867-70.

154. SMITH, K.U. and S.D. ANSELL. 1965.
Closed-loop digital computer system for study of sensory feedback effects of brain rhythms.
American Journal of Physical Medicine. 44(3):125-37.

155. SOLLBERGER, A.R. 1965.
Collapsible 3-dimensional diagram and model.
Med. Biol. Illus. 15(1):12-18.

156. SOLLBERGER, A. 1962.
General properties of biological rhythms.
Ann. N.Y. Acad. Sci. 98(4):757-74.

157. SOLLBERGER, A. 1962.
Outlines of a statistical method of separating exogenous and endogenous components in biological clocks.
In: G. Dell'Acqua, A. Jores, A. Canniggia, and A. Sollberger. Rep. 7th Internat. Conf. Soc. Biol. Rhythm, Panminerva Medica, Turin.

158. SOLOGUB, E.B. 1964.
Autocorrelation and crosscorrelation analysis of "labelled rhythms" in the human EEG during muscle exercise.
Fiziol. Zh. SSR Im. I.M. Sechenova. 50(6):681-89.

159. SPENCER, M.P. and A.B. DENISON. 1960.
An explanation of the major features of the arterial pulse by means of a simple electronic analogy.
Fed. Proc. 19:87.

160. STAHL, W.R. 1967.
A computer model of cellular self-reproduction.
J. Theor. Biol. 14(2):187-205.

161. STEIN, M.L., M.W. DIFFLEY, and G.H. ADKINS. 1963.
Circadian-to-annual frequency domain of human thermovariance resolved by variance spectra and periodograms.
Fed. Proc. 22.

162. SULLIVAN, W.N., M.S. SCHECHTER, S.R. DUTKY, and J.C. KELLER. 1962.
Monitoring electrophysiological responses of cockroaches for space research.
J. Econ. Entomol. 55(6):985.

163. SUSSMAN, A.S., T.L. DURKEE, and R.J. LOWRY. 1965.
A model for rhythmic and temperature-independent growth in "clock" mutants of Neurospora.
Mycopathologia 25:381-96.

164. TAKAHASHI, M. 1966.
Theoretical basis for cell cycle analysis: I. Labelled mitosis wave method.
J. Theor. Biol. 13:202-11.

165. TAYLOR, J.L. 1962.
Rhythmic behavior of lizards in controlled regular or random cyclic and constant temperature environments.
Rep. 7th Internat. Conf. Soc. Biol. Rhythm, Panminerva, Medica, Turin.

166. THARP, G.D. and G.E. FOLK, Jr. 1963.
Analysis of daily rhythms in isolated hearts.
Amer. Zool. 3:4.

167. TISSOT, R. 1969.
Methodologic trial of analysis of the sleep cycle.
Encephale 55:(2):137-69.

168. WATSON, G.S. 1961.
Goodness-of-fit tests on a circle. I.
Biometrica 48:109.

169. WATSON, G.S. 1962.
Goodness-of-fit tests on a circle. II.
Biometrica 49:57.

170. WALTER, D.O. and W.R. ADEY. 1965.
Analysis of brain-wave generators as multiple statistical time series.
IEEE Trans. BME-12, 18-13.

171. WALTER, D.O. 1963.
Spectral analysis for electroencephalograms: Mathematical determination of neurophysiological relationships from records of limited duration.
Exptl. Neurol 8:155-81.

172. WALTER, D.O. and W.R. ADEY. 1963.
Spectral analysis of electroencephalograms recorded during learning in the cat, before and after subthalamic lesions.
Exptl. Neurol. 7:481-501.

173. WEVER, R. 1965.
Circadian rhythms in individuals and populations: An analysis of methods.
Zeitschrift fur vergeichende Physiologie 51(1):1-24.

174. WEVER, R. 1966.
The laws of oscillation for the biological periodicity of the days.
Umsch. Wiss. Tech. 66(14):462-69.

175. WEVER, R. 1966.
Mathematical model for the circadian periodicity.
Zeitschrift fur angewandte Mathematik und Mechanik, Sonderrheft, 46:T148-T157.

176. WEVER, R. 1965.
A mathematical model for circadian rhythms.
In: Circadian Clocks. Edited by J. Aschoff. Amsterdam, North-Holland Publishing Company, p. 47-63.

177. WEVER, R. 1960.
Possibilities of phase-control, demonstrated by an electronic model.
Cold Spring Harbor Symposia on Quantitative Biology. 25: 197-206.

178. WILDER, J. 1962.
Basimetric approach (law of initial value) to biological rhythms.
Ann. N.Y. Acad. Sci. 98(4):1211-1220.

179. WILLIAMS, F.M. 1967.
A model of cell growth dynamics.
J. Theor. Biol. 15(2):190-207.

180. WILLIAMS, H.L. 1966.
Nocturnal EEG profiles and performance.
Psychophysiology 3:164-75.

181. WINGET, C.M., C.A. MEPHAM, and E.G. AVERKIN. 1965.
Variations in intrauterine pH within a circadian rhythm (Gallus domesticus).
Amer. J. Physiol. 208(5):1031-35.

182. YANUSHKEVICHYUS, Z.I. and D.I. ZHEMAITITE. 1966.
Correlation analysis of the cardiac sinus rhythm in well-trained sportsmen and in persons with myocardial infarction in their past history.
Vestnik. Akad. Med. Nauk. SSSR 21(5):41-3.

183. ZATSIORSKII, V.M. and S.K. SARSANIYA. 1966.
Autocorrelational analysis of the duration of cardiac activity cycles in man.
Biofizika 11(5):928-31.

184. ZERBST, E. and E. WILLIAM. 1967.
Temperature adaptation of the heart rate. Analysis by an analog model of thermodynamically open metabolic systems.
Biokbernetik, Mater. Int. Symp., 1st 1:194-99.

185. ZHDANOV, Z.M., et al. 1969.
An automatic analysis of data on the function of external respiration in a human being.
In: Probl. of Space Biol. 6:555-68.

PHARMACOLOGY AND BIOLOGICAL RHYTHMS

Studies on the modification of biological rhythms due to the action of pharmacological agents in animals and plants are included. Alterations in physiological and behavioral rhythms due to dosage, time of administration and drug sensitivity are reported. The synchronization or shifting of rhythms by drugs is also represented.

1. ALADZHALOVA, N.A., and M.E. SAKSON. 1969.
Effect of microelectrophoretic administration of metabolic inhibitors into the cerebral cortex on the infra-slow rhythmic potential oscillations.
Fiziol. Zh. SSSR im. I. M. Sechenova 55(2):145-52.

2. ALLARD, J.R., W.H. WARE, and L.L. BENNETT. 1960.
Negative chronotropism and inotropism of procaine amide in the heart.
Jour. Lab. and Clin. Med. 55(1):129-131.

3. ALPER, M.H. and J. SCHMIER. 1962.
Modification by guanethidine of the chronotropic action of sympathomimetic amines in the heart-lung preparation of the dog pretreated with reserpine.
Jour. Pharmacol. and Exptl. Therap. 137(2):235-241.

4. AMMAR, E.M., and A.N. KUDRIN. 1969.
Antiarrhythmic activity of β-N-hexamethylenimino-p-butoxy-propiophenone, procaine amide, and quinidine against k-strophanthin-induced cardiac arrhythmias in cats.
Farmakol. Toksikol. (Moscow) 32(5):566-70.

5. ANDERSON, L.L., A.M. BOWERMAN, and R.M. MELAMPY. 1965.
Oxytocin on ovarian function in cycling and hysterectomized heifers.
J. Anim. Sci. 24(4):964-968.

6. ANTUNES-RODRIGUES, J., A.P.S. DHARIWAL., and S.M. McCANN. 1966.
Effect of purified luteinizing hormone-releasing factor (LH-RF) on plasma LH activity at various stages of the estrous cycle of the rat.
Proc. Soc. Exp. Biol. Med. 122(4):1001-1004.

7. ASCHBACHER, P.W., and V.J. FEIL. 1970.
Excretion and tissue distribution of the estrus-synchronizing compound 1-α-methylallylthiocarbamoyl-2-methylthiocarbamoylhydrazine in swine.
J. Anim. Sci. 30(3):402-404.

8. ASKEY, J.M. 1962.
Embolism and atrial fibrillation. The effect of restoration of normal rhythm by quinidine.
Amer. J. Cardiol. 9(4):491-495.

9. BABBINI, M., N. MONTANARO, and R. CASOLI. 1966.
An approach to the problem of the interaction between the periodicity of animal behavior and the pharmacological treatment.
Abh. Deut. Akad. Wiss. Berlin, Kl. Med. 2:327-31.

10. BAEKELAND, F. 1966.
The effect of methyl phenidate on the sleep cycle in man.
Psychopharmacologia 10(2):179-183.

11. BAEKELAND, F. 1967.
Pentobarbital and dextroamphetamine sulfate: Effects on the sleep cycle in man.
Psychopharmacologia 11(5):388-396.

12. BELLOMI, C. 1968.
Cortisone therapy synchronized with the circadian biorhythm of the corticoadrenal secretion.
Rass. Trim. Odont. 49:251-257.

13. BERTSCHINGER, H. 1967.
Cycle synchronisation of pigs.
Schweiz Arch. Tierheilk 109(11):588-593.

14. BIDOGGIA, H., et al. 1969.
Nychthemeral rhythm of blood pressure in labile hypertensive patients before and after administration of levo-alpha-methyl-dopa.
Medicina (B. Air) 29:252-8.

15. BIRCHER, P., T. KANAI, and S.C. WANG. 1960.
Mechamism of pentylenethirazol-induced cardiac arrhythmias.
Fed. Proc. 19:111.

16. BLACK, D.L. and R.T. DUBY. 1965.
Effect of oxytocin, epinephrine and atropine on the oestrous cycle of the cow.
J. Reprod. Fertil. 9(1):3-8.

17. BORBELY, A.A. 1966.
The influence of amphetamine on the periodic feeding behavior of the albino rat.
Brain. Res. 1(4):395-402.

18. BOUTSELIS, J.G., N. VORYS, and J.C. ULLERY. 1967.
Control of ovulation time and cycle length with clomiphene.
Amer. J. Obstet. Gynec. 97(7):949-957.

19. BRYAN, H.S. 1960.
Utility of 17α-acetocyprogesterone in delaying estrus in the bitch.
Proc. Soc. Exptl. Biol. and Med. 105(1):23-26.

20. CARBONERA, D. 1966.
Clinical significance of variations in the frequency and cardiac rhythm induced by intravenous administration of succinylcholine in anesthesia.
Acta. Anaesth. 17(1):43-57.

21. CARRARO, A., A. CORBIN, F. FRASCHINI, and L. MARTIN. 1965.
The effect of prepuberal treatment with reserpine on puberty, pituitary luteinizing hormone and the oestrous cycle of the rat.
J. Endocrinol. 32(3):387-393.

22. CATHEY, H.M., J. HALPERIN, and A.A. PIRINGER. 1965.
Relation of N-dimethylamino-succinamic acid to photoperiod, kind of supplementary light, and night temperature, in its effect on growth and flowering of garden annuals.
Hort. Res. 5(1):1-12.

23. CHATTERJEE, A. 1966.
Role of cortisone in the prevention of alloxan diabetic oestrous cycle inhibition in rats.
Acta Anat. 64(4):559-563.

24. CHOU, S.C., S. RAMANATHAN, and W.C. CUTTING. 1968.
Quinacrine: Inhibition of synchronized cell division in Tetrahymena.
Pharmacology 1(1):60-64.

25. CLARKE, J.N., E.M. ROBERTS, A.H. CARTER, and A.H. KIRTON. 1967.
Hormonal synchronization of oestrus in Romney Ewes during the breeding season.
Pro. N. Zeal. Soc. Anim. Prod. 26:107-121.

26. COOKE, J.P. and R.W. BANCROFT. 1966.
Heart rate response of anesthetized and unanesthetized dogs to noise and near-vacuum decompression.
Aerospace Medicine 37(7):704-9.

27. DICZFALUSY, E., U. GOEBELSMANN, E. JOHANNISSON, K.G. TILLINGER, and L. WIDE. 1969.
Pituitary and ovarian function in women on continuous low-dose progesterones: effect of chlormadinone acetate and noreth-

isterone.
Acta Endocrinol. (Copenhaven) 62(4):679-93.

28. DIKSTEIN, S. and F.G. SULMAN. 1966.
Biochemistry of stimulus-response-recovery cycle and its relationship to the pharmacological receptor.
J. Theor. Biol. 12(3):385-396.

29. DOMINO, E.F., et al. 1965.
Nicotine: effect on the sleep cycle of the cat.
Science 150:637-8.

30. DONALDSON, L.E., D.A. LITTLE, and W. HANSEL. 1968.
The duration of oestrus and the time of ovulation in cattle of three breed types with and without synchronisation of oestrus with a progesterone.
Aust. Vet. J. 44(8):364-366.

31. ELKIND, M.M. E. KANO, and H. SUTTON-GILBERT. 1969.
Cell-killing by actinomycin D in relation to the growth cycle of Chinese hamster cells.
J. Cell. Biol. 42(2):366-77.

32. EVANS, H.L., and R.A. PATTON. 1970.
Scopolamine effects on conditioned suppression: influence of diurnal cycle and transitions between normal and drugged states.
Psychopharmacologia 17(1):1-13.

33. FAARVANG, H.J. and O.S. LAURITSEN. 1965.
Circadian variations in sensitivity to glucorticoid evaluated by urinary trypsin inhibitor excretion.
Proc. Soc. Exp. Biol. Med. 102(2):338-340.

34. FANTINI, F., B. TARQUINI, L. SANTINI, and M. CAGNONI. 1967.
Cardiac insufficiency and adrenal cortex function. Daily changes in free plasmatic 17-OHCS and response to administration of dexamethasone.
Rass. Neurol. Veg. 21:240-4.

35. FISCHER, R. 1966.
Sympathetic excitation and biological chronometry.
Int. J. Neuropsychiat. 2(2):116-121.

36. FOOTE, W.C., D.H. MATTHEWS, and C.D. EKRE. 1969.
Influences of estradiol and progestogens on ewes during the breeding season.
Proc. Annu. Meet., West. Scet., Amer. Soc. Anim. Sci. 20:37-42.

37. GENDENSHTEIN, E.I. and L.A. MIKHAILENKO. 1964.
Antiarrhythmic action of serpentine during some experimental disturbances of auricular and ventricular rhythm.
Byul. Eksp. Biol. Med. 57(4):70-73.

38. GIURGEA, C. and F. MOEYERSOONS. 1965.
The initial effect of certain psychotrophic drugs on the EEG: Phenomenon of amplification of rapid rhythm.
Int. J. Neuropharmacol. 3(6):579-582.

39. GOLIKOV, P.P. 1966.
The hypnotic action of medinal and the antihypnotic effect of caffeine as a function of season of the year.
Farmakologiya i Toksikologiya. 29(5):540-542.

40. GONZALEZ, E., L. NOVAKOVIC, G. CONCHA, and M. PENNA. 1969.
Influence of autonomic drugs on rhythmicity of isolated quinea pig heart.
Arch. Biol. Med. Exp. 5(1-3):68-76.

41. GOTTSCHALK, L.A., GLESER, G.C., CLEGHORN, J.M., STONE, W.M., and WINGET, C.N. 1970.
Prediction of changes in severity of the schizophrenic syndrome with discontinuation and administration of phenothiazines in chronic schizophrenic patients: Language as a predictor and measure of change in schizophrenia.
Comp. Psychiat. 11(2):123-140.

42. GUKASYAN, I.A., M.Kh. CHAILAKHYAN, and E.L. MILYAEVA. 1970.
Effect of day length and gibberellin on the rate of growth, flowering, and differentiation of Perilla nankinensis apexes.
Fiziol. Rast. 17(1):63-70.

43. GUTGESELL, H.P., et al. 1969.
Effect of propranolol of epinephrine-induced changes in cardiac rhythm and arterial potassium in dogs anesthetized with cyclopropane.
J. Pharmacol. Exp. Ther. 170:231-6.

44. HAAS, K.B. 1961.
Delaying estrus in the bitch.
Illinois Vet. 4(4):84-88.

45. HAFEZ, E.S.E., M.R. JAINUDEEN, G.H. KROENING, and A.A. EL-BANNA. 1966.
Use of progesterone and thiocarbamyoyl-hydrazine compounds for estrous synchronization in gilts.
J. Amer. Veterinary Med. Ass. 149(1):35-41.

46. HANSEL, W., P.V. MALVEN, and D.L. BLACK. 1961.
Estrous cycle regulation in the bovine.
Jour. Animal Sci. 20(3):621-625.

47. HARDMAN, H.F., and P. BUKHAMANA. 1966.
Cardiac seasonal variation, a qualitative change in pharmacological response to ethylenediamine.
Pharmacol. Exp. Therap. 151(2):300-306.

48. HARTMANN, E. 1966.
Reserpine: Its effect on the sleep-dream cycle in man.
Psychopharmacologia 9(3):242-247.

49. HAYDU, G.G. 1962.
Manic-depressive rhythm: Its pharmacologic modification and the nature of the self structure.
Ann. N. Y. Acad. Sci. 98(4):1126-38.

50. HERSHBERGER, L.G., P.M. ZAMBOANGA, and C.R. THOMPSON. 1962.
Preliminary report on the effect of ethamoxytriphetol on estrus and pregnancy in the bitch.
Amer. Jour. Vet. Res. 23(92):168-69.

51. HILFRICH, H.J. 1970.
Different reactions of the uterus to pharmacological and mechanical stimuli at different times of the day.
Z. Geburtch. Gynaekol. 172(1):72-9.

52. HOFFMAN, J.S. and E.F. DOMINO. 1969.
Comparative effects of reserpine on the sleep cycle of man and cat.
J. Pharmacol. Exp. Ther. 170(2):190-198.

53. HOWELL, W.E. and W.C. WOOLFITT. 1964.
Hormonal control of estrus and its effect on fertility in cycling ewes.
Can. J. Anim. Sci. 44(2):195-99.

54. HUTCHEON, D.E. and D.K. ROWLAND. 1961.
Diurnal variations in urinary electrolytes during thiazide therapy.
Fed. Proc. 20:411.

55. JEWETT, R.E. and S. NORTON. 1966.
Effects of some stimulant and depressant drugs on sleep cycles of cats.
Exp. Neurol 15(4):463-474.

56. KALLADIS, E. 1966.
Effect of halothane and chloroformin combination with adrenaline (norepinephrine) on the spontaneous rhythmicity of isolated and in vitro cultivated myocardial cells.
Acta. Biol. Med. Ger. 17(3):327-33.

57. KARSCH, F.J. and B.R. POULTON. 1967.
Synchronization of estrus in the guinea pig with 6 -methyl-17-α-acetoxyprogesterone (MAP) and the effect on subsequent fertility.
J. Anim. Sci. 26(3):549-552.

58. KHADZHIEVA, E.D. 1969.
Effect of caprolactam on the sexual cycle.
Gig. Tr. Prof. Zabol. 13(10):22-5.

59. KHAZAN, N. and L.A. SCHROEDER. 1964.
Recent aspects of sleep-awake cycle.
10(5/6):338-48.

60. KLEINFELD, M., O. SHADE, and F. GRUEN. 1969.
Action of diphenylhydantoin on rhythmicity and contractility of cultured embryonic heart cells.
J. Pharmacol. Exp. Ther. 170(1):84-90.

61. KOELLA, W.P. 1969.
Neurohumoral aspects of sleep control.
Biol. Psychiat. 1(2):161-77.

62. KOJIMA, M.K. 1960.
Cyclic changes of the cortex and the cytoplasm of the fertilized and the activated sea urchin egg. II. The formation of clear spots by the hypertonicity, ether and urethane.
Embryologia 5(2):178-85.

63. KOSAREV, V.E. 1968.
Synchronization of estrus in Karakul sheep by using megestrol acetate.
Sb. Nauch. Rab., Vses. Nauch.-Issled. Inst. Zhivotnovod. 13:84-6.

64. KOWALEWSKI, K. 1960.
Time response of lipid changes in cockerels after single dose of estradiol cyclopentylpropionate.
Proc. Soc. Exptl. Biol. and Med. 104(4):634-636.

65. KRAMER, D., et al. 1970.
Long-term testing of 2-(2,6-dichlorpheaylamino)-2-imidazoline hyrdochloride with special reference to the effect on blood pressure and carbohydrate metabolism.
Arzneimittelforschung 20:519-21.

66. KRIEGER, D.T. and H.P. KRIEGER. 1967.
Circadian pattern of plasma 17-hydroxycorticosteroid: Alteration by anticholinergic agents (cat).
Science 155(3768):1421-1422.

67. KRIEGER, D.T. and F. RIZZO. 1969.
Serotonin mediation of circadian periodicity of plasma 17-hydroxycorticosteroids.
Am. J. Physiol. 217(6):1703-7.

68. KULIN, H.E. , K. METZL, and R. PETERSON. 1966.
Urinary tetrahydrocortisone and tetrahydrocortisol in infants born of mothers treated with corticosteroids during pregnancy.
J. Pediat. 69(4):648-51.

69. LABOS, E., J. SALANKI, and G.R. KLITYNA. 1964.
The effect of cholinotropic drugs on the rhythmic activity of glochidia of fresh-water mussel (Andonta cygnea L.).
Acta Biol. Acad. Sci. Hung. 15(2):119-28.

70. LAGUCHEV, S.S. 1969.
Effect of hydrocortisone on the mitotic cycle.
Dokl. Acad. Nauk. SSSR 187(1):230-2.

71. LEES, P., et al. 1970.
Influence of halothane and catecholamines on heart rate and rhythm in the horse.
Brit. J. Pharmacol. 39:149-59.

72. LEVY, I.E.S. 1961.
Quantitative variations of urinary neutral 17-ketosteroids in schizophrenics from the action of Taractan.
Rev. Fac. Farm. y. Bioquim. 23(89/90):76-77.

73. LICHT, P. and A.K. PEARSON. 1969.
Effects of mammalian gonadotropins (FSH and LH) on the testes of the lizard Anolis carolinensis.
Gen. Comp. Endocrinol. 13:367-81.

74. LUTSCH, E.F. and R.W. MORRIS. 1967.
Circadian periodicity in susceptibility to lidocaine hydrochloride.
Science 156:100-102.

75. LYMAN, C.P. and R.C. O'BRIEN. 1961.
Effect of various drugs on the hibernating cycle.
Fed. Proc. 20:211.

76. LYNN, J.E., W.E. COLLINS, E.K. INSKEEP, W.H. McSHAN, and L.E. CASIDA. 1965.
Effects of gonadotropins, oxytocin and glucose on the bovine corpus luteum at the fourteenth day of the estrual cycle.
J. Anim. Sci. 24(3):790-794.

77. MCNAIR SCOTT, D.B. and A.M. PAKOSKEY. 1967.
Cyclic effect of steroids, cortisone and estradiol on enzyme activities of uterus of ovariectomized rat.
Fed. Proc. 26:845.

78. MEYER, R.K. and C.E. McCORMACK. 1967.
Ovulation in immature rats treated with ovine follicle-stimulating hormone: Facilitation by progesterone and inhibition by continuous light.
J. Endocrinol. 38:187-194.

79. MILLICHAP, J.G. 1966.
Circadian analysis of phenobarbital induced hyperkinesia in mice and hamsters.
Proc. Soc. Exp. Biol. Med. 121(3):754-757.

80. MITZNEGG, P., F. HEIM, and B. MEYTHALER. 1970.
Influence of endogenous and exogenous cyclic 3', 5'-AMP on contractile responses induced by oxytocin and calcium in isolated rat uterus.
Life Sci. 9(3)(Pt. 1):121-8.

81. MONTANARO, N., R. CASOLI, and M. BABBINI. 1965.
Physiological and pharmacological aspects of the regulation of the periodicity of motor behavior in the rat.
Arch. Ital. Sci. Farmacol. 15:86-89.

82. MONTI, J.M. 1968.
The effect of haloperidol on the sleep cycle of the cat.
Experientia 24(11):1143.

83. MURASHINA, A.N. 1966.
Age-related features of the oestrous cycle and of the sensitivity of the sexual organs of the rat to estradiol dipropionate.
In: The regulation of functions at different age periods.
Nauk. dumka: Kiev. 163-166.

84. NADEAU, R.A. and T.N. JAMES. 1966.
The behavior of atrio-ventricular nodal rhythm following direct perfusion of the sinus node.
Can. J. Physiol. Pharmacol. 44(2):317-324.

85. NAIR, V. and R. CASPER. 1969.
Influence of light on daily rhythm in hepatic drug metabolizing enzymes in rat.
Life Sci. 23:1291-8.

86. NALLAR, R. 1960.
The action of cortical hormones and artificial corticoids on the periodic vaginal cycle of the rat.
Rev. Soc. Argentina Biol. 36(7/8):369-374.

87. NAQUET, R., K.F. KILLAM, and J. ENGEL. 1966.
The "sleep-wakefulness" cycles in two animal species placed under various experimental conditions.
Rev. Neurol. (Paris) 115(3):438-443.

88. NAYLER, W.G., et al. 1970.
An effect of ST 155 (clonidine), 2-(2,6-dichlorophenylamino)-2-imidazoline hydrochloride, Catapres on relationship between blood pressure and heart rate in dogs.
Europ. J. Pharmacol. 10:161-7.

89. NELLOR, J.E., J.E. AHRENHOLD, N.L. FIRST, and J.A. HOEFER. 1961.
Estrus, ovulation and fertility in gilts subsequent to the oral administration of 6-methyl-17-acetoxyprogesterone.
Jour. Anim. Sci. 20(1):22-30.

90. NISWENDER, G.D., C.C. KALTENBACH, R.P. SHUMWAY, J.N. WILTBANK, and D.R. ZIMMERMAN. 1965.
Alteration of ovarian activity in cycling beef heifers with small, daily injections of estradiol.
J. Anim. Sci. 24(4):986-989.

91. PARADISE, R.R., and V. STOELTING. 1965.
Conversion of acetyl strophanthidin-induced ventricular tachycardia to sinus rhythm by ethyl alcohol.
Arch. Int. Pharmacodyn. Therap. 157(2):312-321.

92. PARENTI, U. and G. PORRARO. 1967.
The action of methyltestosterone on the sexual cycle of an opalinid.
Ric. Sci. 37(4):379-380.

93. PAULY, J.E. and L.E. SCHEVING. 1964.
Temporal variations in the susceptibility of white rats to pentobarbital sodium and tremorine.
Int. J. Neuropharmacol. 3(6):651-658.

94. PIRREILI, A., et al. 1969.
The behavior of the colloido-osmotic pressure of the blood of rats treated with angiotensin.
Boil. Soc. Ital. Biol. Sper. 45:1129-32.

95. POND, W.G., W. HANSEL, J.A. DUNN, R.W. BRATTON, and R.H. FOOTE. 1965.
Estrous cycle synchronization and fertility of gilts fed progestational and estrogenic compounds.
J. Anim. Sci. 24(2):536-540.

96. REINBERG, A., Z. ZAGULA-MALLY, and J. GHATA. 1969.
Circadian reactivity rhythm of human skin to house dust, penicillin, and histamine.
The Journal of Allergy. 44(5):292-306.

97. REZABEK, K. and V. JELINEK. 1962.
The effect of some drugs used in the therapy of malignant tumors on the genital cycle of the rat.
Neoplasma (Czech) 9(2):151.

98. RIBONI, E., G.P. PACE, B. TIEGHI, and F. ZANCANER. 1969.
Circadian rhythm and long-acting cortisones. A prednisone preparation in lipid solution for parenteral use.
Gass. Int. Med. Chir. 74(21):1920-32.

99. ROBERTS, J. and W. MODELL. 1961.
Pharmacological evidence for the importance of catecholamines in cardiac rhythmicity.
Circulation Res. 9(1):171-76.

100. ROVERE, A. and M. PENNA. 1969.
Pharmacological interferences in the relation of rhythm to contractile force in mammalian ventricular muscle.
Arch. Biol. Med. Exp. 5(1-3):44-54.

101. ROWLANDS, D.J., G. HOWITT, and P. MARKMAN. 1965.
Propranolol (Inderal) in disturbances of cardiac rhythm.
Brit. Med. J. 5439:891-94.

102. SAARIMAA, H.A. 1963.
The effect of hydrochlorthiazide on the normal diurnal rhythm of the body temperature in man.
Ann. Med. Exp. Biol. Fenn. 41(3):311-14.

103. SAVCHENKO, O.N. and G.S. STEPANOV. 1964.
Gonadotropines, estrogens, and pregnanediol in the normal menstrual cycle.
Probl. Endokrinol. Gormonoterap. 10(4):7-13.

104. SAXENA, B.B., G. LEYENDECKER, C. WEIYU, H.M. GANDY, and R.E. PETERSON. 1969.
Radioimmunoassay of follicle-stimulating (FSH) and luteinizing (LH) hormones by chromatoelectrophoresis.
Acta Endocrinol (Copenhagen) 142:185-206.

105. SCHAFF, G., M.T. SCHWERTZ, and G. MARBACH. 1962.
Influence of alcohol and caffeine on spontaneous motility, cardiac frequency, respiratory rate and rectal temperature during sleep.
J. Physiol. (Paris) 54(2):411-412.

106. SCHUSTER, C.R. and J. ZIMMERMAN. 1961.
Timing behavior during prolonged treatment with di-amphetamine.
Jour. Exptl. Anal. Behavior 4(4):327-330.

107. SILLANS, D., et al. 1969.
Influence of carbonic anhydride anesthesia on circulatory rhythm in Bombys mori (caterpillar).
C. R. Acad. Sci. (D) (Paris). 269:1209-12.

108. SNYDER, S.H. and J. AXELROD. 1965.
Circadian rhythm in pineal serotonin: Effect of monoamine oxidase and resperpine.
Science 149(3682):542-544.

109. SRIVASTAVA, L. and C.W. TURNER. 1967.
Comparison of biological activity of injected and orally administered L-thyroxine (T_4), L-triiodothyronine (T_3) and thyroprotein in fowls.
Proc. Soc. Exp. Biol. Med. 126(1):157-61.

110. SUGIMOTO, J., K. TAMINO, C. KADOKAWA, N. IIDA, and M. MORITA. 1964.
L-methionine as a modulator of atrial rhythmicity in rabbit and guinea pig.

Jap. J. Pharmacol. 14(2):150-60.

111. TAKEBE, K., H. KUNITA, S. SAWANO, Y. HORIUCHI, and K. MASHIMO. 1969.
Circadian rhythms of plasma growth hormone and cortisol after insulin.
J. Clin. Endocrinol. Metab. 29(12):1630-33.

112. TISSOT, R. 1965.
The effects of certain drugs on the sleep cycle in man.
Progr. Brain. Res. 18:175-177.

113. TOYODA, J. 1964.
The effects of chlorpromazine and imipramine on the human nocturnal sleep electroencephalogram.
Folia Psychiat. Neurol. Jap. 18(3):198-221.

114. TOYOTA, T. 1969.
Diurnal change of plasma insulin in diabetics with sulfonylurea treatment.
Tohoku J. Exp. Med. 98:345-56.

115. UL'YANOVA, O.V. 1965.
Effect of Chloracysine 2-chloro-10-(3-dimethylaminopropionyl)-phenothiazine on experimental disturbances in atrial rhythm.
Byul. Eksp. Biol. Med. 59(4):69-72.

116. WAHLSTROM, G. 1965.
The circadian rhythm of self-selected rest and activity in the canary and the effects of barbiturates, reserpine, monoamine oxidase inhibitors and enforced dark periods.
Acta Physiol. Scand. 65(250):1-67.

117. WAHLSTROM, G. and E. WIDERLOV. 1968.
The effects of (±)-amphetamine sulphate on the self-selected circadian rhythm of activity and rest in the canary.
Brit. J. Pharmacol. 34:218-219.

118. WAHLSTROM, G. 1964.
Effects of reserpine on the self-selected circadian rhythm in the canary.
Acta Pharmacol. Toxicol. 21(4):347-364.

119. WAHLSTROM, G. 1964.
Influence of psychopharmacological agents on circadian rhythm in the canary studied by self selection of light and darkness.
Annals of N.Y. Acad. Of Sci. 117:320-336.

120. WEBSTER, P.L. and D. DAVIDSON. 1969.
Changes in the duration of the mitotic cycle induced by colchicine and indol-3-ylacetic acid in Vicia faba roots.
J. Exp. Bot. 20(64):671-85.

121. WHITMAN, J.R. and E. PERETZ. 1969.
The effect of nembutal on the estrous activity cycle.
Physiol. Behav. 4(6):963-64.

122. WILLIAMS, H.L., et al. 1969.
Alpha chloralose and nocturnal physiological patterns.
Psychopharmacologia. 15:28-38.

123. WINKLER, G. and M. HERRMANN. 1967.
The influence of ACTH and corticosteroids on the rhythm of adrenocortical function in the 10-day-rebound-phenomenon.
Rass. Neurol. Veg. 21:187-198.

124. WINTENBERGER-TORRES, S. 1967.
Effect of progesterone and ovarian steroids on egg segmentation in the ewe.
Ann. Biol. Anim. Biochim. Biophys. 7(4):391-406.

125. WOLLENBERGER, A. 1964.
Acute effect of triiodothyronine on the spontaneous rhythm of isolated in vitro cultured heart cells.
Arch. Exp. Pathol. Pharmakol. (Naunyn-Schmiedeberg) 249(3): 288-294.

126. ZARROW, M.X. and J. YOCHIM. 1961.
Dilation of the uterine cervix of the rat accompanying changes during the estrous cycle, pregnancy and following treatment with estradiol, progesterone, and relaxin.
Endocrinology 69(2):292-304.

127. ZHDANOVA, N.F. 1966.
Changes in sinus rhythm due to the action of dicoumarin quinidine, and combinations of them.
Kardiologiya 6(2):82.

128. ZIMMERMANN, E. and V. CRITCHLOW. 1969.
Effects of intracerebral dexamethasone on pituitary-adrenal function in female rats.
Am. J. Physiol. 217(2):392-396.

MECHANISMS OF BIOLOGICAL RHYTHMS

Biological rhythms studies to delineate the mode of action and inter-relationships of rhythm components in biological systems were collected. Mechanisms for biological oscillation are studied from the viewpoints of internal and external control. Biochemical pathways, cellular kinetics and systems interactions are included.

1. ABINDER, A.A., A.S. CHECHULIN, V.A. FROLOV, and E.A. DEMUROV. 1966.
Bioelectric changes in the cardiac cycle arising from the stimulation of various sections of the hypothalamus (rabbit).
Kardiologiya 6(3):81-82.

2. ADAMS, T.S. 1970.
Ovarian regulation of the corpus allatum in the housefly, Musca domestica.
J. Insect. Physiol. 16:349-360.

3. ADKISSON, P.L. 1965.
Light-dark reactions involved in insect diapause.
In: J. Aschoff, ed. Circadian Clocks. Proceedings of the Feldafing Summer School. Amsterdam, North-Holland Pub. Co. P. 344-350.

4. ALADZHALOVA, N.A., and A.V. KOL'TSOVA. 1963.
Hourly fluctuations in the electrical activity of the brain structure associated with coagulation of the hypothalamus-hypophyseal system.
Biul. Eksp. Biol. Med. 55:7-13.

5. AMLER, G. 1960.
The problem of the pathological beta rhythm.
Psychiat. et Neurol. 139(6):397-405.

6. ANDREWS, R.V. and G.E. FOLK, Jr. 1964.
Circadian metabolic patterns in cultured hamster adrenal glands.
Comp. Biochem. Physiol. 11:393-409.

7. ANNAN, O. 1963.
Experiments on photoperiodic regulation of the testis cycle in two species of the thrush genus Hylocichla.
Auk 80(2):166-174.

8. ANONYMOUS. 1960.
Insects and length of day.
Nature 186(4727):774-775.

9. ASCHOFF, J. 1967.
Circadian rhythms in birds.
Proc. Int. Ornithol Congr. 14:81-105.

10. AXELROD, J. 1966.
Control of catecholamine and indoleamine metabolism by sym-

pathetic nerves (rat).
Wenner-Gren Center Int. Symp. Ser. 5:189-209.

11. BAILLAUD, L. 1967.
Biological rhythms.
Bull. Ass. Reg. Etude Rech. Sci. 8(33):46-56.

12. BARBER, J. 1968.
Light-induced uptake of potassium and chloride by Chlorella pyrenoidosa.
Nature 217(5131):876-878.

13. BARTOLI, V., B. DORIGO, E. TEDESCHI, G.P. BITI, and M.R. VOEGELIN. 1970.
Circadian periodicity of calf blood flow in subjects with intermittent claudication.
Angiology 21(4):215-23.

14. BEKKER, Z.E. and T.S. SHARKOVA. 1969.
Two categories of biochemical regulators of circadian rhythms of zonation in fungi.
Biol. Nauk. 12(7):92-97.

15. BENOIT, J. 1964.
The structural components of the hypothalamo-hypophyseal pathway, with particular reference to photostimulation of the gonads in birds.
Ann. N. Y. Acad. Sci. 117:23-34.

16. BERLINER, M.D. and P.W. NEURATH. 1966.
Control of rhythmic growth of a Neurospora "clock" mutant by sugars.
Canad. J. Microbiol. 12:1068-1070.

17. BHARGAVA, K.P. and M.L. GUPTA. 1966.
A study of central adrenergic mechanisms in the regulation of the oestrous cycle of albino mice.
Brit. J. Pharmacol. Chemotherap. 26(3):601-605.

18. BISCOE, T.J. 1967.
Observations on a rhythmic variation in the cat carotid body chemoreceptor activity which has the same period as respiration.
J. Physiol. 190(3):389-412.

19. BRADY, J. 1967.
Control of the circadian rhythm of activity in the cockroach: II. The role of the sub-oesophageal ganglion and ventral nerve cord.
J. Exp. Biol. 47(1):165-178.

20. BRADY, J. 1969.
How are insect circadian rhythms controlled?
Nature (London) 223:781-784.

21. BORBERLY, A.A. 1966.
The influence of amphetamine on the periodic feeding behavior of the albino rat.
Brain Res. 1(4):395-402.

22. BRAHMACHARY, R.L. 1967.
Physiological clocks.
Int. Rev. Cytol. 21:65-89.

23. BULLOUGH, W.S. and E.B. LAURENCE. 1966.
The diurnal cycle in epidermal mitotic duration and its relation to chalone and adrenalin.
Exp. Cell. Res. 43(2):343-350.

24. BULLOUGH, W.S. and E.B. LAURENCE. 1965.
Epigenetic mitotic control.
In: A Sigrid Juselius Foundation Symposium on control of cellular growth in adult organisms. Helsinki, Finland, Academic Press: London and New York. P. 28-40.

25. BUNNING, E. and W. KONITZ. 1962.
Diurnal changes in nuclear membranes (Elodea canadensis).
Die Naturwissenschaften 49(1):20.

26. BUNNING, E. 1964.
The physiological clock. Endogenous diurnal rhythms and biological chronometry.
Springer-Verlag: Berlin; Academic Press, Inc.: New York.
145 pages.

27. CHANCE, B. K. PYE, and J. HIGGINS. 1967.
Waveform generation by enzymatic oscillators.
IEEE Spectrum 4:79-86.

28. CHEIFETZ, P., N. GAFFUD, and J.F. DINGMAN. 1968.
Effects of bilateral adrenalectomy and continuous light on the circadian rhythm of corticotrophin in female rats.
Endocrinology 82(6):1117-1124.

29. CLOUDSLEY-THOMPSON, J.L. 1961.
Rhythmic activity in animal physiology and behaviour.
New York Academic Press. 236 pages.

30. COBURN, S.P. 1968.
Daily rhythm in plasma tyrosine and phenylalanine.
Proc. Soc. Exp. Biol. Med. 129(2):338-343.

31. CORNER, M. 1964.
Rhythmicity in the early swimming of anuran larvae.
J. Embryol. Exp. Morphol. 12(4):665-671.

32. CUMMING, B.G. 1969.
Circadian rhythms of flower induction and their significance in photoperiodic response.
Can. J. Bot. 47(2):309-324.

33. DANILEVSKII, A.S., N.I. GORYSHIN, and V.P. TYSHCHENKO. 1968.
Endogenous rhythms and the problem of photoperiodism in insects.
Vestn. Leningrad Univ. Ser. Biol. 23(2):39-45.

34. DeF. ROBERTS, S.K. 1966.
Circadian activity rhythms in cockroaches: III. The role of endocrine and neural factors.
J. Cell. Physiol. 67(3 pt. 1):473-486.

35. DEMENT, W.C. 1967.
Sleep.
In: Mammalian Hibernation III. Proceedings of the Third International Symposium on Natural Mammalian Hibernation, University of Toronto, Toronto, Canada. Oliver & Boyd, Edinburgh and London. Edited by K.C. Fischer, A.R. Dawe, C.P. Lyman, E. Schonbaum, and F.E. South. P. 175-199.

36. DIMICH, D., V. DIGESI, SCARPA, G., M. MAIOLI. 1967.
Circadian rhythm of plasma angiotensinase activity in normal humans.
Studi Sassar., Sez. II. 45(6):613-19.

37. DOL'NIK, V.R. 1961.
Mechanism for the energy preparation for birds for migration and factors which determine it.
In: Ecology and the migration of birds of the Baltic Region. P. 281-288. Riga, Akad. Nauk Latviisk. SSR.

38. DOL'NIK, V.R. 1964.
The mechanism of photoperiodical regulation of the endogenous rhythm of sexual cycles in birds.
Zool. Zh. 43(5):720-734.

39. DOL'NIK, V.R. 1965.
Role of light and darkness in seasonal changes in the sensitivity of photoperiodic regulators in finches.
Zool. Zh. 44(9):1423-1424.

40. DOSSETOR, J.B., H.M. GORMAN, and J.C. BECK. 1964.
The diurnal rhythm of urinary electrolyte excretion. II. In certain disease states.
Metab. Clin. Exp. 13(12):1439-1455.

41. DRIESSCHE, T.V. 1966.
The role of the nucleus in the circadian rhythms of Acetabularia mediterranea.
Biochim. Biophys. Acta 126(3):456-470.

42. EHRET, C.F. and E. TRUCCO. 1967.
Molecular models for the circadian clock. I. The chronon concept.
J. Theor. Biol. 15:240-262.

43. EHRET, C.F. and J.S. BARLOW. 1960.
Toward a realistic model of a biological period-measuring mechanism.
Cold Spring Harbor Symposia on Quantitative Biology. 25:217-220.

44. EPIFANOVA, O. I. 1962.
Possible ways of hormonal regulation of the mitotic cycle.
Tsitologiya 4(2):128-136.

45. EVANS, K.J. 1966.
Responses of the locomotor activity rhythms of lizards to simultaneous light and temperature cycles.
Comp. Biochem. Physiol. 19:91-103.

46. FARELL, G., D. POWERS, and T. OTANI. 1968.
Inhibition of ovulation in the rabbit: Seasonal variation and the effects of indoles.
Endocrinology 83(3):599-603.

47. FELDMAN, J.F. 1967.
Lengthening the period of a biological clock in Euglena by cycloheximide, an inhibitor of protein synthesis.
Proc. Nat'l. Acad. Sci. USA 57:1080-1087.

48. FELDMAN, S. 1964.
Visual projections to the hypothalamus and preoptic area.
Annals of N.Y. Acad. of Sci. 117:53-68.

49. FENYO, E. and T. HASZNOS. 1964.
Periodic EEG complexes in subacute panencephalitis: Reactivity, response to drugs and respiratory relationships.
Electroenceph. Clin. Neurophysiol. 16:446-458.

50. FRAPS, R.M. 1961.
Ovulation in the domestic fowl.
In: "Control of Ovulation," edited by C.A. Villee. Pergamon Press, Oxford.

51. FRENKEL, R. 1967.
Control of glycolytic oscillations in beef heart supernatant fraction.
Johnson Res. Fndn., Univ. of Pennsylvania, Philadelphia, Pennsylvania.

52. FUJITA, Y. and T. SATO. 1964.
Intracellular records from hippocampal (brain) pyramidal cells in rabbit during theta rhythm activity.
J. Neurophysiol. 27(6):1011-1025.

53. GOODWIN, B.C. 1966.
An entrainment model for timed enzyme synthesis in bacteria.
Nature (London) 209(5022):479-481.

54. GUBSKII, L.V. and V.I. GUBSKII. 1968.
Characteristics of several circadian rhythms in patients with dienciphalic pathologies.
Zhur. Neuropath. i Psikhiat. Korsakov 68(3):353-358.

55. GUBSKII, V.I. and L.V. GUBSKII. 1969.
Circadian rhythms and the mechanism of circadian organization.
Usp. Sovrem. Biol. 68(1):90-105.

56. GUREVICH, B. Kh. and I.V. MEDVEDEVA. 1969.
Triggering timing and "biological clock" characteristics in response to single critical night action in photoperiodism.
Biofizika 14(1):173-178.

57. HARDELAND, R. and L. RENSING. 1968.
Circadian oscillation in rat liver tryptophan pyrrolase and its analysis by substrate and hormone induction.
Nature (London) 219:619-621.

58. HARKER, J.E. 1961.
Diurnal rhythms.
Ann. Rev. Entomol. 6:131-146.

59. HARTMANN, E. 1968.
The 90-minute sleep-dream cycle.
Arch. Gen. Psychiat. 18(3):280-286.

60. HASTINGS, J.W. 1965.
Molecular aspects of circadian systems.
In: Circadian Clocks. Edited by J. Aschoff. Amsterdam, North-Holland Pub. Co. P. 167-182.

61. HAUGAARD, N. 1963.
Role of the phosphorylase enzymes in cardiac contraction: A proposed theory for the rhythmical production of energy in the heart.
Nature (London) 197(4872):1072-1074.

62. HAUGAARD, N. 1963.
A theory for the rhythmical production of energy in the heart.
Amer. Jour. Med. Sci. 245(4):505.

63. HAWKING, F. and K. GAMMAGE. 1968.
The periodic migration of microfilariae of Brugia malayi and its response to various stimuli.
Amer. J. Trop. Med. Hyg. 17(5):724-729.

64. HAYASHI, T. 1967.
The relationship between circadian sleep and gamma-hydroxy-butyrate (4 HB) in brain.
Exp. Med. Surg. 25:148-155.

65. HENDRICKS, S.B. 1963.
Metabolic control of timing.
Science 141:21-27.

66. HILDEBRANDT, G. 1967.
The time factor in adaptation.
Biometeorology 2(1):258-275.

67. HIROSHIGE, T. and T. SATO. 1970.
Circadian rhythm and stress-induced changes in hypothalamic content of corticotropin-releasing activity during postnatal development in the rat.
Endocrinology 86:1184.

68. HOFFMAN, K. 1965.
Clock-mechanisms in celestial orientation of animals.
In: Aschoff, J. ed. Circadian Clocks; Proc. of the Feldafing Summer School. Amsterdam, North-Holland Publ. Co. P. 426-441.

69. HOLUBAR, J. 1960.
The time sense and photic driving in man.
Physiol. Bohemoslov. 9(6):482-487.

70. HOLUBAR, J. 1961.
The sense of time: an electrophysiological study of its mechanisms in man.
Cambridge, Mass., MIT Press. 134 pages.

71. HOUDAS, Y. 1967.
The circadian rhythm of temperature.
Lille Med. 12(1):82-89.

72. HOWE, G.F. 1964.
Time course of photosynthetic rhythms in Phaseolus vulgaris L. as related to changes in degree of stomatal opening.
Ohio J. Sci. 64(5):378-384.

73. JOHANSSON, B. and D.F. BOHR. 1966.
Rhythmic activity in smooth muscle from small subcutaneous arteries.
Amer. J. Physiol. 210(4):801-806.

74. JOHANSSON, B. and B. LJUNG. 1967.
Sympathetic control of rhythmically active vascular smooth muscle as studied by a nerve-muscle preparation of portal vein.
Acta Physiol. Scand. 70(3/4):299-311.

75. KAHN, N. and S.C. WANG. 1966.
Pontine pneumotaxic center and central respiratory rhythm.
Amer. J. Physiol. 211(2):520-524.

76. KAMBERI, I.A. and Y. KOBAYASHI. 1970.
Monoamine oxidase activity in the hypothalamus and various other brain areas and in some endocrine glands of the rat during the estrous cycle.
J. Neurochem. 17(2):261-268.

77. KARAKASHIAN, M.W. and J.W. HASTINGS. 1963.
The effects of inhibitors of macromolecular biosynthesis upon the persistent rhythm of luminescence in Gonyaulax.
Jour. Gen. Physiol. 47(1):1-12.

78. KAYSER, C. and A.A. HEUSNER. 1967.
The nychthemeral rhythm of energy expenditure. Study of comparative physiology.
J. Physiol. (Paris) 59(1):3-116.

79. KIM, S.J. 1960.
Relation between ovarian function and electroencephalogram.
1. Report: Variation of electroencephalogram during normal menstrual cycle.
Igaku Kenkyu 30(11):3060-3067.

80. KLINGBERG, F. and L. PICKENHAIN. 1965.
About rhythmic salvos induced in the bulbus olfactorius of the rat and their correlation with the behavior of the animal.
Acta Biol. Med. Ger. 15(½):58-70.

81. KOBAYASHI, T., T. KOBAYASHI, J.KATO, and H. MINAGUCHI. 1963.
Fluctuations in choline acetylase activity in hypothalamus of rat during estrous cycle and after castration.
Endocrinol. Ja. Pon. 10(3):175-182.

82. LEES, A.D. 1963.
The role of photoperiod and temperature in the determination of parthenogenetic and sexual forms in the aphid Megoura viciae Buckton. III. Further properties of the material switching mechanism in apterous aphids.
J. Insect Physiol. 9(2):153-164.

83. LEES, A.D. 1966.
Photoperiodic timing mechanisms in insects.
Nature (London) 210(5040):986-989.

84. LEWIS, P. R. and M.C. LOBBAN. 1967.
Dissociation of diurnal rhythms in human subjects living on abnormal time routines.
Quart. J. Exp. Physiol. 42:371-386.

85. LICHTENSTEIGER, W. 1969.
Cyclic variations of catechol amine content in hypothalamic nerve cells during the estrous cycle of the rat, with a concomitant study of the substantia nigra.
J. Pharmacol. Exp. Ther. 165(2):204-15.

86. LOWENSTEIN, O. and I.E. LOEWENFELD. 1964.
The sleep-waking cycle and pupillary activity.
Ann. N.Y. Acad. Sci. 117:142-156.

87. MACDOWALL, F.D.H. 1964.
Reversible effects of chemical treatments on the rhythmic exudation of sap by tobacco roots.
Canadian Jour. Bot. 42(1):115-122.

88. MACHADO, C.R.S., L.E. WRAGG, and A.B.M. MACHADO. 1969.
Circadian rhythm of serotonin in the pineal body of immunosympathectomized immature rats.
Science 164:442-443.

89. MACHADO, C.R.S., A.B.M. MACHADO, and L.E. WRAGG. 1969.
Circadian serotonin rhythm control: Sympathetic and non-sympathetic pathways in rat pineals of different ages.
Endocrinology 85:846-848.

90. MARTEL, P.J., G.W.G. SHARP, S.A. SLORACH, and H.J. VIPOND. 1962.
A study of the roles of adrenocortical steroids and glomerular filtration rate in the mechanism of the diurnal rhythm of water and electrolyte excretion.
Jour. Endocrinol. 24(2):159-169.

91. MARTIN, M.M. and D.E. HELLMAN. 1964.
Temporal variation in Su-4885 responsiveness in man: Evidence in support of circadian variation in ACTH secretion.
Jour. Clin. Endocrinol. and Metab. 24(3):253-260.

92. McCORMACK, C.E. and R.K. MEYER. 1964.
Minimal age for induction of ovulation with progesterone in rats: evidence for neural control.
Dept. of Zoology, University of Wisconsin, Madison, Wisconsin.
Endocrinology 74:793.

93. MICHAEL, R.P. 1962.
Neural mechanisms and the control of sexual receptivity in the cat.
Animal Behavior 10(3/4):391.

94. MILANO, M. 1962.
Periodic modifications of dermographic reactivity in diverse phases of the menstrual cycle.
Bibl. Anat. 4:651-660.

95. MILSUM, J.H. 1969.
Optimization aspects in biological control theory.
In: Advances in Biomedical Engineering and Medical Physics, Volume 1. Edited by S.N. Levine. New York, Interscience Publishers. P. 243-278.

96. MIYATA, H. and Y. YAMAMOTO. 1969.
Rhythms in respiratory metabolism of Lemna gibba G_3 under continuous illumination.
Plant Cell Physiol. 10(4):875-889.

97. MODLINGER-ODERFER, M. 1962.
Histophysiological investigations of the diurnal rhythm in the nucleus supraopticus and nucleus paraventricularis of the albino mouse.
Endokrinol (Leipzig) 43(½):45-60.

98. MONAKHOV, K.K. and L.V. TISHANINOVA. 1964.
Spatial distribution of the sources of rhythmic activity in the cerebral cortex in man and animals.
Zh. Nevropatol. Psikhiat. Im. S. S. Korsakova. 64(4):520-526.

100. MORETTI, G., C. GIACOMETTI, V. BOIDO, and A. REBORA. 1963.
Histamine, serotonia and mast cells in the skin of the rat during the hair cycle.
Jour. Invest. Dermatol. 40(4):205-212.

101. MORI, S. 1960.
Influence of environmental and physiological factors on the daily rhythmic activity of a sea-pen.
Cold Spring Harbor Symposia on Quantative Biology. 25:333-344.

102. MORLEY, A.A. 1966.
A neutrophil cycle in healthy individuals.
Lancet 7475:1220-1222.

103. NALBANDOV, A.V. 1962.
The role of the endocrine system in the control of certain biological rhythms in birds.
Ann. N. Y. Acad. Sci. 98(4):916-925.

104. NICHOLS, C.T. and F.H. TYLER. 1967.
Diurnal variation in adrenal cortical function.
Ann. Rev. Med. 18:313-324.

105. NISHIITSUTSUJI-UWO, J. and C.S. PITTENDRIGH. 1968.
Central nervous system control of circadian rhythmicity in the cockroach Leucophaea madeirae, Periplaneta americana: III. The optic lobes, locus of the driving oscillations.
Z. Vergl. Physiol. 58(1):14-46.

106. NISHIYAMA, I. 1966.
Physiological studies on the mechanism of seasonal variation in osmotic pressure in Fatsia jopaonica leaf cells I.
J. Fac. Sci. Univ. Tokyo Sect. III Bot. 9(6/9):219-239.

107. OLIVI, O. and R. GENOVA. 1962.
Research on the physiological biorhythm of the free plasma 17, 21-dihydroxy-20-corticosteroids in the nursling.
Folia Endocrinol. 15(4):424-430.

108. OTSUKA, Y., F. SAKAI, A. SAKUMA, and Y. SAJI. 1963.
Periodic changes in electroencephalograms.
Jap. J. Pharmacol. 13(3):253-258.

109. OTTO, E. 1968.
Regulation of time-perception.
Psychiatrie, Neurologie, und medizinische Psychologie 20(2): 53-59.

110. PACKER, L., K. UTSUMI, and M.G. MUSTAFA. 1966.
Oscillatory states of mitochondria. I. Electron and energy transfer pathways.
Arch. Biochem. Biophys. 117:381-393.

111. PADY, S.M., C.L. KRAMER, and R. CLARY. 1968.
Periodicity in aeciospore release in Gymnosporangium juniperi-virginianae.
Phytopathology 58(3):329-331.

112. PARDI, L. 1960.
Innate components in the solar orientation of littoral amphipods.
Cold Spring Harbor Symposia on Quantitative Biology 25: 395-401.

113. PASSANO, L.M. and C.B. McCULLOUGH. 1964.
Co-ordinating systems and behavior in Hydra. I. Pacemaker system of the periodic contractions.
J. Exp. Biol. 41(3):643-664.

114. PASSANO, L.M. and C.B. McCULLOUGH. 1965.
Coordinating systems and behavior in hydras. II. The rhythmic potential system.
J. Exp. Biol. 42(2):205-232.

115. PASSANO, L.M. and C.B. McCULLOUGH. 1962.
The light response and the rhythmic potentials of hydra.
Proc. Nat. Acad. Sci. USA 48(8):1376-1382.

116. PAVLIDIS, T. 1969.
Populations of interacting oscillators and circadian rhythms.
J. Theor. Biol. 22:418-436.

117. POWELL, B.L. 1966.
The control of the 24 hour rhythm of colour change in juvenile Carcinus maenas (L).
Proc. Roy. Irish Acad. Sect. B. 64(21):379-399.

118. PYE, E.K. 1969.
Biochemical mechanisms underlying the metabolic oscillations in yeast (Saccharomyces carlsbergensis).
Can. J. Bot. 47(2):271-285.

119. PYE, E.K. 1966.
Control of glycolysis in cell-free extracts of yeast showing oscillations of DPNH level.
Johnson Res. Fndn., Univ. of Pennsylvania, Phila., Pa.

120. PYE, K. and B. CHANCE. 1966.
Sustained sinusoidal oscillations of reduced pyridine nucleotide in a cell free extract of Saccharomyces carlsbergensis.
Proc. Natl. Acad. Sci. 55:888-894.

121. QUAY, W.B. 1967.
The significance of darkness and monoamine oxidase in the nocturnal changes in 5-hydroxytryptamine and hydroxyindole-O-methyl-transferase activity of the macaques epiphysis cerebri.
Brain Res. 3:277-286.

122. QUEIROZ, O. 1968.
On the acid metabolism of Crassulaceae. III. Variations of enzymatic activity under the action of photoperiodism and thermoperiodism.
Physiol. Veg. 6(2):117-136.

123. QUEIROZ, O. 1969.
Photoperiodism and PEP (phosphoenolpyruvate carboxylase and malic enzyme activity in leaves of Kalanchoe blossfeldiana.
Phytochemistry 8(9):1655-1663.

124. RADNOT, M. and E. WALLNER. 1964.
Periodicity in the eosinophyl count in the adrenal cycle.
Ann. N. Y. Acad. Sci. 117:244-253.

125. RAMIREZ, V.D. and C.H. SAWYER. 1965.
Fluctuations in hypothalamic LH-RF (luteinizing hormone-releasing factor) during the rat estrous cycle.
Endocrinology 76(2):282-289.

126. RASHEVSKY, N. 1969.
Mathematical theory of biological periodicities: II. Effect of active transport.
Bull. Math. Biophys. 31(3):591-603.

127. REIS, D.J. and R.J. WURTMAN. 1968.
Diurnal changes in brain noradrenalin.
Life Sciences 7(1):91-98.

128. RENNER, M. 1960.
The contribution of the honey bee to the study of time-sense and astronomical orientation.
Cold Spring Harbor Symposia on Quantitative Biology. 25: 361-367.

129. RETIENE, K. F. SCHULZ, and J. MARCO. 1967.
Circadian rhythmicity of pituitary adrenal function under resting and stress conditions in rats.
Rass. Neurol. Veg. 21:217-221.

130. RICHARD, G. 1967.
Levels and rhythmization of the activity of animals.
Bull. Soc. Zool. Fr. 92(4):673-686.

131. RICHTER, C.P. 1960.
Biological clocks in medicine and psychiatry: Shock-phase hypothesis.
Proc. Nat'l. Acad. Sci. USA 46:1506-1530.

132. ROBERTS, S.K. deF. 1966.
Circadian activity rhythms in cockroaches. III. The role of endocrine and neural factors.
J. Cell. Physiol. 67:473-486.

133. ROTH, W.D., R.J. WURTMAN, and M.D. ALTSCHULE. 1962.
Morphologic changes in the pineal parenchyma cells of rats exposed to continuous light or darkness.
Endocrinology 71(6):888-892.

134. ROTHCHILD, I. 1967.
The central nervous system and disorders of ovulation in women.
Amer. J. Obstet. Gynecol. 98(5):719-747.

135. RUEDI, B. J. WERTHEIMER, J.P. FELBER, and A. VANNOTTI. 1967.
Disturbances of plasma cortisol circadian rhythm and of cortisol-ACTH feedback mechanism in central nervous system diseases.
Rass. Neurol. Veg. 21:199-215.

136. SAARIMAA, H.A. 1963.
The effect of hydrochlorthiazide on the normal diurnal rhythm of the body temperature in man.
Ann. Med. Exp. Biol. Fenn. 41(3):311-314.

137. SABA, G.C., A. CARNICELLI, P. SABA, and V. MARESCOTTI. 1963.
Diurnal rhythm in the adrenal cortical secretion and in the rate of metabolism of corticosterone in the rat. II: Effects of hypothalamic lesions.
Acta Endocrinol. 44(3):413-415.

138. SALANKI, J. 1965.
Oxygen level as a specific regulator in the rhythmic activity of fresh-water mussel (Anodonta cygnea L.).
Acta Biol. Acad. Sci. Hung. 15(3):299-310.

139. SAMPSON, H. 1965.
Deprivation of dreaming sleep by two methods. I. Compensatory REM (rapid eye movement) time.
Arch. Gen. Psychiat. 13(1):79-86.

140. SARAPUU, L. 1964.
Phlorizin as a β-inhibitor and the seasonal dynamics of the products of its metabolism in the shoots of the apple tree.
Fiziol. Rast. 11(4):607-614.

141. SATOH, T., T. OGAWA, and K. TAKAGI. 1965.
Sweating during daytime sleep.
Jap. J. Physiol. 15(5):523-531.

142. SCHARRER, E. 1964.
Photo-neuro-endocrine systems: General concepts.
Annals of the New York Academy of Sciences. 117(1):13-21.

143. SCHERRER, H. 1962.
Effect of basal blood pressure levels on blood pressure responses to central nervous stimulation.
Ann. N.Y. Acad. Sci. 98:1302-1315.

144. SCHERRER, J. and O. BENOIT. 1966.
Levels of physiologic alertness: States of wakefulness and sleep.
Ann. Biol. Clin. 24:107-124.

145. SCHMIDT, C.F. 1962.
Cycles in concepts of respiratory control.
Arch. Internatl. Pharmacodyn. Therap. 140(3/4):506-513.

146. SCHMIDT-KOENIG, K. 1960.
Internal clocks and homing.
Cold Spring Harbor Symposia on Quantitative Biology 25:389-393.

147. SCHWARTZ, M. and C. SHAGASS. 1962.
Effect of different states of alertness on somatosensory and auditory recovery cycles.
Electroenceph. Clin. and Neurophysiol. 14(1):11-20.

148. SCHWEIGER, H.G. and E. SCHWEIGER. 1965.
The role of the nucleus in a cytoplasmic diurnal rhythm.
In: Circadian Clocks. Edited by J. Aschoff. Amsterdam, North-Holland Publishing Co., P. 195-197.

149. SCOTT, B.J.H. 1962.
Feedback-induced oscillations of five-minute period in the electric field of the bean root.
Ann. N. Y. Acad. Sci. 98:890-900.

150. SHAMBAUGH, G.E. D.A. WARNER, and W.R. BEISEL. 1967.
Hormonal factors altering rhythmicity of tyrosine-alphaketo-glutarate transaminase in rat liver.
Endocrinology 81(4):811-818.

151. SHAPOVALOV, A.I. 1960.
Effect of temperature on the fast and slow potentials of the rhythmically active muscle fibre, with intracellular recording.
Biofizika (Transl.) 5(3):314-323.

152. SHERWOOD, S.L. 1967.
The abandonment of the absolute.
Ann. N.Y. Acad. Sci. 138:600-615.

153. SIGDESTAD, C.P., J. BAUMAN and S.W. LESHER. 1969.
Diurnal fluctuations in the number of cells in mitosis and DNA synthesis in the jejunum of the mouse.
Exp. Cell. Res. 58(1):159-162.

154. SILVA, P.S. 1965.
Cerebral mechanisms for the perception of space, time and memory. Psychological time and biological time.
Rev. Hosp. Clin. Fac. Med. S. Paulo 20(5):235-238.

155. SIMONS, D.G. and R.L. JOHNSON. 1965.
Heart rate petterns observed in medical monitoring.
Aerosp. Med. 36:504-513.

156. SNYDER, S.H. and J. AXELROD. 1965.
Circadian rhythm in pineal serotonin: Effect of monoamine oxidase and resperpine.
Science 149(3683):542-544.

157. SNYDER, S.H., M. ZWEIG, and J. AXELROD. 1964.
Control of the circadian rhythm in serotonin content of the rat pineal gland.
Life Sci. 3(10):1175-1179.

158. SPANGLER, R.A. and F.M. SNELL. 1961.
Sustained oscillations in a catalytic chemical system.
Nature 191(4787):457-458.

159. SREEBNY, L.M. and D.A. JOHNSON. 1969.
Diurnal variation in secretory components of the rat parotid gland.
Arch. Oral. Biol. 14(4):397-405.

160. STEINBERG, R.H. 1966.
Oscillatory activity in the optic tract of cats and light adaptation.
J. Neurophysiol. 29(2):139-156.

161. STERN, H. 1961.
Periodic induction of deoxyribonuclease activity in relation to the mitotic cycle.
J. Biophys. Biochem. Cytol. 9:271-277.

162. STEVENS, P.M., P.B. MILLER, C.A. GILBER, T.N. LYNCH, and R.L. JOHNSON. 1966.
Influence of long-term lower body negative pressure on the circulatory function of man during prolonged bed rest.
Aerospace Medicine 37(4):357-67.

163. STRUMWASSER, F. 1967.
Neurophysiological aspects of rhythms.
In: The Neurosciences: A study program. Edited by G.C. Quarton, T. Melnechuk, and F.O. Schmitt. New York, Rockefeller University Press, p. 516-528, 887, 888.

164. SUSSMAN, M. 1967.
Evidence of temporal and quantitative control of genetic transcription and translation during slime mold development.
Fed. Proc. 26:77-83.

165. SVIDERSKII, V.L. 1965.
Mechanisms involved in rhythmic neuron activity in the motor apparatus of insects. (Sound apparatus in cicads).
Zh. Evolyuts Biokhim Fiziol. 1(2):166-174.

166. SVIDERSKII, V.L. 1969.
Nervous control of rapid rhythmic muscle movements of insects (sound-producing system of cicadas and wing apparatus of the locust).
Tr. Vses. Entonoll Obshchest. 53:94-131.

167. SVORAD, D. and I.G. KARMANOVA. 1966.
Synchronizing mechanisms in the release of the rhombencephalic phase of sleep.
Nature 212(5063):713-714.

168. SWEENEY, B.M., C.F. TUFFLI, and R.H. RUBIN. 1967.
The circadian rhythm in photosynthesis in Acetabularia in the presence of actinomycin D, puromycin, and chloramphenicol.
J. Gen. Physiol. 50:647-659.

169. SWEENEY, B.M. 1965.
Do cells have clocks?
Discovery 34-39.

170. SWEENEY, B.M. 1969.
Rhythmic phenomena in plants.
Academic Press, New York. 148 pages.

171. SWEENEY, B.M. 1969.
Transducing mechanisms between circadian clock and overt rhythms in Gonyaulax.
Can. J. Bot. 47(2):299-308.

172. TISSOT, R. 1965.
The effects of certain drugs on the sleep cycle in man.
Progr. Brain. Res. 18:175-177.

173. TOOR, M., S. MASSRY, A.L. KATZ, and J. AGMON. 1966.
Diurnal variations in the composition of blood and urine of man living in hot climate.
Nephron. 2(6):334-354.

174. TYSHCHENKO, V.P. 1966.
Two-oscillatory model of the physiological mechanism of the photoperiodic reaction of insects.
Zhur. Obshch. Biol. 27(2):209-22.

175. UNGAR, F. 1964.
In vitro studies of adrenal-pituitary circadian rhythms in the mouse.
Ann. N.Y. Acad. Sci. 117(1):374-385.

176. VENABLES, P.H. 1960.
Periodicity in reaction time.
Brit. J. Psychol. 51:37-43.

177. VERNIKOS-DANELLIS, C.M. WINGET, and N.W. HETHERINGTON. 1969.
Diurnal rhythm of the pituitary-adrenocortical response to stress--effect of constant light and constant darkness.
COSPAR Plenary Meeting, 12th Prague, Czechoslovakia.
May 11-24, 1969. Paper. 14 pages.

178. VILLABLANCA, J. 1966.
Behavioral and polygraphic study of "sleep" and "wakefulness" in chronic decerebrate cats.
Electroenceph. Clin. Neurophysiol. 21:562-577.

179. VORONIN, L.G. and V.F. KONOVALOV. 1966.
Electrographic data on the operation of "biological clocks" of the human brain.
Translated into English from Vopr. Psikhologii (Moscow) 6:87-94.

180. VYSHINEPOL'SKII, Yu. Ya. 1969.
Effect of guanethidine on the circadian rhythm of catecholamines, dopa and dopamine excretion in patients suffering from hypertension.
Sov. Med. 32(1):52-56.

181. WALDRON, I. 1967.
Mechanisms for the production of motor output pattern in flying locusts.
Jnl. of Exper. Biol. 47:201-212.

182. WENT, F.W. 1960.
Photo- and thermoperiodic effects in plant growth.
Cold Spring Harbor Symposia on Quantitative Biology 25:221-230.

183. WILKINS, M.B. 1967.
An endogenous rhythm in the rate of carbon dioxide output of Bryophyllum. V. The dependence of rhythmicity upon aerobic metabolism.
Planta (Berl.) 72(1):66-77.

184. WILKINS, M.B. 1967.
An endogenous rhythm in the rate of carbon dioxide output of Bryophyllum. V. The dependence of rhythmicity upon aerobic metabolism.
Planta. 72(1):66-77.

185. WILLIAMS, H.L., et al. 1969.
Alpha chlorase and nocturnal physiological patterns.
Psychopharmacologia. 15:28-38.

186. WOLFSON, A. 1966.
Environmental and neuroendocrine regulation of annual gonadal cycles and migratory behavior in birds.
Recent Progr. Hormone Res. 22:177-244.

187. WOLFSON, A. 1960.
Regulation of annual periodicity in the migration and reproduction of birds.
Cold Spring Harbor Symposia on Quantitative Biology. 25:507-514.

188. WRIGHT, B.E. 1963.
Endogenous activity and sporulation in slime molds.
Ann. N. Y. Acad. Sci. 102(3):740-754.

189. WURTMAN, R.J. 1969.
The pineal gland and its role in the establishment of biological rhythms.
In: IV Simposio Panamericano de Parmacologia y Terapeutica, Aug. 24-26, 1967. Acad. Nac. Med. Mex. Excerpta Med. Int'l. Cong. Ser. No. 185:41-46.

190. WURTMAN, R.J. 1969.
Time-dependent variations in amino acid metabolism--Mechanism of the tyrosine transaminase rhythm in rat liver.
In: Advances in enzyme regulation. Volume 7. Oxford, Pergamon Press, p. 57-67.

191. ZESKOV, P. 1969.
Electrogenesis of sleep.
Electroenceph. Clin. Neurophysiol. 27:553.

192. ZIMMER, R. 1962.
Phase displacement and other disturbed light activity of the endogenous daily periodic petal movement in Kalanchoe blossfeldiana.
Planta 58:283-300.

DEVELOPMENT OF BIOLOGICAL RHYTHMS

The factors influencing the establishment of rhythmic patterns are included in this collection. Mechanisms of postnatal ontogenesis leading to synchronized natural frequencies are investigated in mammals. The organization of sleep rhythms in human infants is of particular interest. The temporal sequence of insect development is included as an indicator of the research in that field.

1. ADER, R. 1970.
Development of rhythmic processes.
Activ. Nerv. Sup. (Praha) 12:138-139.

2. ADER, R. 1969.
Early experiences accelerate maturation of the 24-hour adrenocortical rhythm.
Science 163:1225-1226.

3. ADOLF, E.F. 1967.
Ranges of heart rates and their regulations at various ages (rat).
American Journal of Physiology 212:595.

4. ALLEN, C., and J.W. KENDALL. 1967.
Maturation of the circadian rhythm of plasma corticosterone in the rat.
Endocrinology 80:926-930.

5. ANDERS, T.F. and H.P. ROFFWARG. 1968.
The relationship between infant and maternal sleep.
Psychophysiology 5(2):227-228.

6. ARSHAVSKII, V.V. 1964.
Mechanism of the changes of the natural rhythm of the heart and respiration in large horned cattle and pigs in postnatal ontogenesis.
Fiziol Zh SSSR IM I M Sechenova 50(10):1256-1263.

7. ASCHOFF, J. 1960.
Exogenous and endogenous components in circadian rhythms.
In: Biological Clocks. Cold Spring Harbor Symposia on Quantitative Biology, 25 (1960) Cold Spring Harbor, Long Island, New York, The Biological Laboratory, 1961, p 11-27; discussion, p 27-8.

8. BARNWELL, F.H. 1960.
A solar daily variation in oxygen consumption of the embryonated egg.
Proc. Soc. Exp. Biol. Med. 105(2):312.

9. BAUTZMANN, H., R. SCHROEDER, and E. DUNKER. 1960.
Amnionmotoric and rocking movements of the embryo in the hens egg.
Anat. Anz. 108.

10. BERNHARD, C.G. and B.A. MEYERSON. 1968.
Early ontogenesis of electrocortical activity.
In: Clinical Electroencephalography of Children. P. Kellaway and I. Petersen (eds.). Almquist & Wiksell, Stockholm. Pp. 11-29.

11. BIRIUKOVICH, A.A. 1969.
Frequency and rhythm of heart contractions during sleep in infants.
Vop. Okhr. Materin Dets 14:46-51.

12. BIRYUKOVICH, A.A. 1969.
Diurnal rhythm of the cardiac activity in newborns according to days of life.
Pediatriya 48(10):30-33.

13. BRUCE, V.G. 1960.
Environmental entrainment of circadian rhythms.
In: Biological Clocks. Cold Spring Harbor Symposia on Quantitative Biology, 25 (1960). Cold Spring Harbor, Long Island, New York, The Biological Laboratory, 1961, p. 29-48.

14. BRYAN, G.T. and J.E. OVERALL. 1970.
A study of the development of the human circadian periodicity.
Pediat. Res. 4:63-70.

15. CLOUDSLEY-THOMPSON, J.L. 1961.
Diurnal rhythm of activity in insects and their ecological significance.
Entomologist. I. 94(1173):40-45, Feb., 1961; II. 94(1174): 70-73, March, 1961; III. 94(1175):89-94, April, 1961.

16. CLOUDSLEY-THOMPSON, J.L. 1961.
Rhythmic activity in animal physiology and behaviour.
Academic Press, New York.

17. DREYFUS-BRISAC,C. 1966.
The bioelectric development of the central nervous system during early life.
In: Human Development. F. Falkner (ed.). Saunders, Philadelphia.

18. DREYFUS-BRISAC,C. and N. MONOD. 1965.
Sleep of premature and full-term neonates--a polygraphic study.
Proc. Roy. Soc. Med. 58:6.

19. ELLINGSON, R. 1964.
Studies of the electrical activity of the developing human brain.
In: The Developing Brain, Progr. Brain Res., 9, 26.

20. EMDE, R.N. and D. R. METCALF. 1968.
Behavioral and EEG correlates of undifferentiated eye movement states in infancy.
Psychophysiology 5(2):227.

21. FISCHER, M. and E. ULICH. 1961.
Dependence on time of day of short-time concentration in children and youths of various ages.
Z. Exp. Angew. Psychol. 8:282-296.

22. FRANK, G. and J. CHASE. 1968.
Sleep rhythms in premature infants.
Psychophysiology 5(2):227.

23. FRANKS, R.D. 1967.
Diurnal variation of plasma 17-hydroxycorticosteroids in children.
J. Clin. Endocrinol. 27:75.

24. GARMA, L. and R. VERLEY. 1967.
Activites cellulaires corticales etudies par electrodes implantees chez le lapin nouveau-ne.
J. Physiol. Paris 59:357-376.

25. GOLDIE, L., J.A.H. CURTIS, U. SVENDSEN, and N.R.C. ROBERTSON. 1968.
Abnormal sleep rhythm in mongol babies.
Lancet 1:229-230.

26. GOLDIE, L. and C. VAN VELZER. 1965.
Innate sleep rhythms.
Brain 88:1043-1056.

27. GOLDIE, L. 1965.
Sleep cycles in premature infants.
Develop. Med. Child Neurol. 7:317-319.

29. HALBERG, F. 1961.
Circadian aspects of mitosis and metabolism.
Rept. Ross Conf. Pediat. Res. 39:41-44.

30. HARKER, J.E. 1965.
The effect of a biological clock on the developmental rate of Drosophila pupae.
J. Exp. Biol. 42(2):323-338.

31. HARKER, J.E. 1965.
The effect of photoperiod on the developmental rate of Drosophila pupae.
J. Exp. Biol. 43(3):411-423.

32. HARKER, J. 1964.
The physiology of diurnal rhythms.
Cambridge Univ. Press, London.

33. HARNER, R.N. 1961.
Quantification of convulsive periodicity.
Rept. Ross Conf. Pediat. Res. 39:45-48.

34. HARRIS, R. and J.P.M. TIZARD. 1960.
The electroencephalogram in neonatal convulsions.
J. Paediat. 57:501-520.

35. HAUS, E. and F. HALBERG. 1962.
The circadian adrenal cycle and its significance for the adrenocortical reactivity.
Wien. Z. Inn. Med. 43(8):361-370.

36. HELLBRUEGGE, Th. 1967.
Chronophysiology of the child.
Verhandlungen der deutschen Gesellschaft fuer innere Medizin 73. Kongress. P. 896-921.

37. HELLBRUEGGE, T., J. EHRENGUT LANGE, J. RUTENFRANZ, and K. STEHR. 1964.
Circadian periodicity of physiological functions in different stages of infancy and childhood.
Ann. N. Y. Acad. Sci. 117(1):361-373.

38. HELLBRUGGE, T. 1960.
The development of circadian rhythm in infants.
Cold Spring Harbor Symposia on Quantitative Biology 25: 311-323.

39. HELLBRUEGGE, Th. 1965.
Development of day-night-periodicity in childhood.
Wiss. Z. Humboldt-Univ. Berlin Math. Nat. R. 14:263-275.

40. HELLBRUEGGE, Th., J. LANGE, J. RUTENFRANZ, and K. STEHR. 1963.
On the origin of a 24-hour periodicity of physiologic functions in infancy.
Fortschrt. Med. 81:19.

41. HELLBRUGGE, T. 1968.
Ontogenesis of circadian rhythms in the child.
Symposium Bel-Air III. J. de Ajuriaguerra, ed. Masson et Cie., Paris. P. 159-183.

42. HELLBRUEGGE, T. 1965.
Temporal structures in child development.
Monatsschr. Kinderheilk., 113:252-262.

43. HEUSNER, A. 1965.
Sources of error in the study of diurnal rhythm in energy metabolism.
In: Circadian Clocks. Edited by Jurgen Aschoff. Amsterdam, North-Holland Publishing Co., p. 3-12.

44. HIROSHIGE, T. and T. SATO. 1970.
Circadian rhythm and stress-induced changes in hypothalamic content of corticotropin-releasing activity during postnatal development in the rat.
Endocrinology 86:1184.

45. HOFER, M.A., and M.F. REISER. 1969.
Development of cardiac rate regulation in preweanling rats.
Psychosom. Med. 31(5):372-88.

46. HUTTENLOCHER, P.R. 1967.
Development of cortical neuronal activity in the neonatal cat.
Exptl. Neurol. 17:247-262.

47. HUTTENLOCHER, P.R. and M.D. RAWSON. 1968.
Neuronal activity and adenosine triphosphatase in immature cerebral cortex.
Exptl. Neurol. 22:118-129.

48. IVERSON, L.L., J. DeCHAMPLAIN, J. GLOWINSKI, and J. AXELROD. 1967.
Uptake, storage and metabolism of norepinephrine in tissues of the developing rat.
J. Pharm. Exp. Therap. 157:509.

49. JOHANSEN, K. 1962.
Response to heat and cold in lower mammals.
Int. J. Biometer. 6(1):3.

50. KELLAWAY, P. and J. CRAWLEY. 1964.
A primer of electroencephalography of infants. Sections I and II: Methodology and criteria of normality.
Baylor University College of Medicine, Houston, Texas.

51. KLEITMAN, N. 1961.
Development of circadian rhythm in the infant.
In: Circadian Systems. Rept. Ross Conf. Pediat. Res. 39:35-37.

52. KOCH, J. 1968.
The change of conditioned orienting reactions in 5 month old infants through phase shift of partial biorhythms.
Human Development 11(2):124-137.

53. KRAUER, B. and L. DETTLI. 1969.
Diurnal variations in the elimination rate of sulfisomidine in children during the first year of life.
Chemotherapy (Basel) 14:1-6.

54. KRAUER, B., P. SPRING, and L. DETTLI. 1968.
Zur pharmakokinetik der sulfonamide im ersten lebensjahr.
Pharmacologia Clin. 1:47-53.

55. KRAUER, B. 1969.
Rate of elimination of the sulfisoxazole in children in first year of life: Diurnal fluctuations.
Int. Z. Klin. Pharmakol. Ther. Toxik. 2:217-220.

56. KRULISOVA, H. 1970.
Heart rate changes during conditioning in the human infant.
Activ. Nerv. Sup (Praha) 12:135.

57. LEVINE, S., G.C. HALTMEYER, G.D. KARAS, and V.H. DENENBERG. 1967.
Physiological and behavioral effects of infantile stimulation.
Physiol. Behav. 2:55.

58. LIPTON, E.L., A. STEINSCHNEIDER, and J.B. RICHMOND. 1966.
Autonomic function in the neonate. VII. Maturation changes in cardiac control.
Child Development 37:1.

59. MARTE, E. 1961.
Circadian susceptibility in relation to administration of pharmacologic agents.
Rept. Ross Conf. Pediat. Res. 39:52-55.

60. METCALF, D.R., et al. 1967.
The development of the EEG sleep patterns in normal infants and children: a longitudinal developmental study.
Electroenceph. Clin. Neurophysiol. 23:82.

61. MINARD, J.G. 1968.
REM as response: developmental change of the function of eye movement.
Psychophysiology 5(2):226.

62. MINIS, D.H. and C.S. PITTENDRIGH. 1963.
Circadian oscillation controlling hatching: Its ontogeny during embryogenesis of a moth.
Science 159(3314):534-536.

63. MORIN, J. and P. CONSTANT. 1968.
Contribution to the study of ontogenesis of nycthemeral rhythm of activity in the golden hamster (Mesocricetus auratus).
C. R. Hebd. Seances Acad. Sci. Ser. D. Sci. Natur (Paris) 265(15):1071-1074.

64. MYBURGH, A.C. 1963.
Diurnal rhythms in emergence of mature larvae from fruit and eclosion of adult Pterandrus rosa (KSH) and Ceratitis capitata (Wied.).
S. African Jour. Agric. Sci. 6(1):41-46.

65. NOLTE, R. 1968.
Das trace alternant im Schlaf-EEG bei reifen, unreifen and hypotrophen Neugeborenen.
In: 14th Jahrestagung der Deutsche EEG-Gesellschaft. F. Schwarzer (ed.).

66. NOWOSIELSKI, J.W. and R.L. PATTON. 1963.
Studies on circadian rhythm of the house cricket, Gryllus domesticus L.
Jour. Insect. Physiol. 9(4):401-410.

67. OSWALD, I. 1962.
Sleeping and waking: Physiology and psychology.
Amsterdam, Elsevier Publishing Co. 232 pages.

68. PARMELEE, A.H., Jr., H.R. SCHULZ, M.A. DISBROW, and M. LITT. 1961.
Sleep pattern of the newborn.
J. Pediat. 58:241-250.

69. PARMELEE, A.H., Jr. 1961.
A study of one infant from birth to eight months of age.
Acta Paediat. 50:160-170.

70. PARMELEE, A.H., Jr., et al. 1962.
Activity and inactivity cycles during the sleep of premature infants exposed to neutral temperatures.
Biol. Neonatorum (Basel) 4(6):317-339.

71. PARMELEE, A.H., Jr. 1964.
Infant sleep patterns: from birth to 16 weeks of age.
J. Pediat. 65:576-582.

72. PARMELEE, A.H., Jr., F.J. SCHULTE, Y. AKIYAMA, W.H. WENNER, M.A. SCHULTZ, and E. STERN. 1968a.
Maturation of EEg activity during sleep in premature infants.
Electroencephalog. Clin. Neurophysiol. 24:319-329.

73. PARMELEE, A.H., Jr., Y. AKIYAMA, M.A. SCHULTZ, W.H. WENNER, F.J. SCHULTE, and F. STERN. 1968b.
The electroencephalogram in active and quiet sleep in infants.
In: Clinical Electroencephalography of Children. P. Kellaway and I. Petersen (eds.). Almquist & Wiksell, Stockholm. P. 77-88.

74. PARMELEE, A.H., Jr. 1969.
A periodic cerebral rhythm in newborn infants.
Exp. Neurol. 25(4):575-584.

75. PARMELEE, A.H., Jr. 1969.
Sleep cycles in infants.
Develop. Med. Child Neurol. 11:794-795.

76. PECHSTEIN, J. 1966.
The development of medical statistics in their importance to social pediatrics.
In: Handbuch der Kinderheilkunde, B. III, Springer, Berlin. P. 1023.

77. PITTENDRIGH, C.S. 1970.
Circadian systems. V. The driving oscillation and the temporal sequence of development.
National Academy of Sciences, Proceedings, 65:500-507.

78. PITTENDRIGH, C.S. 1960/1961.
On temporal organization in living systems.
Harveg Lect. 56:93-125.

79. PRECHTL, H.F.R., Y. AKIYAMA, P. ZINKIN, and D.K. GRANT. 1968.
Polygraphic studies of the full-term newborn: 1. Technical aspects and qualitative analysis.
In: Clinics in Developmental Medicine No. 27. Edited by R. MacKeith and M. Bax. Spastics International Medical Publications in Association with William Heinemann Medical Books Ltd, London.

80. REMMERT, H. 1962.
The emergence rhythm of insects.
Steiner Verlag, Weisbaden.

81. RENSING, L. 1965.
Circadian rhythms in the course of ontogeny.
In: Aschoff, J., editor. Circadian Clocks. North Holland, Amsterdam. P. 399-405.

82. RENSING, L. and R. HARDELAND. 1967.
The effect of circadian rhythm on the development of Drosophila.
J. Insect Physiol. 13(10):1547-1568.

83. RENSING, L. 1969.
Ontogenesis and hormaonal control of circadian rhythms.
Gottingen, Akademie der Wissenschafter, Nachrichten, Mathematisch-physikalische Klasse, 8:57-70.

84. RENSING, L. 1965.
Ontogenetic timing and circadian rhythms in insects.
In: Aschoff, J. Circadian Clocks. North Holland, Amsterdam. P. 406-412.

85. RIND, H. and E. GLADTKE. 1964.
Pharmaco-kinetic investigations on sulfonamide therapy in 3-month-old children.
MSCHR. Kinderheilk. 112:239-240.

86. ROFFWARG, H.P., J.N. MUZIO, and W.C. DEMENT. 1966.
Ontogenetic development of the human sleep-dream cycle.
Science 152:604-619.

87. RUTENFRANZ, J. 1961.
The development of circadian system functions during infancy and childhood.
Rept. Ross Conf. Pediat. Res. 39:38-41.

88. RUTENFRANZ, J., Th. HELLBRUEGGE, K. STEHR, and P. OBERHOFF. 1964.
On the behavior of blood pressure of children and adolescents during physical activity and during rest.
ZSCHR. Kinderhk. 89:227-244.

89. SCHNEIRLA, T.C. 1965.
Aspects of stimulation and organization in approach/withdrawal process underlying vertebrate behavioral development.
In: Advances in the Study of Behavior. Acad. Press, New York.

90. SCHWARTZ, E., and R.L. BAEHNER. 1968.
Diurnal variation of serum iron in infants and children.
Acta Paediat. Scand. 57:433-435.

91. SIMONNET, H. 1964.
Biological cycles and rhythms in animals(bibliography).
Biol. Med. 53(3):266-330.

92. SOLLBERGER, A. 1964.
The control of circadian glycogen rhythms.
Ann N. Y. Acad. Sci. 117(1):519-554.

93. STEHR, K. 1960.
The physiology of various kidney functions in the young infant.
Kinderaerztl. Praxis 28:541.

94. STERMAN, M.B. and T. HOPPENBROUWERS. 1968.
Development of a rest-activity cycle in the human fetus.
Psychophysiology 5(2):226.

95. STERN, E., A.H. PARMELEE, Jr., Y. AKIYAMA, M.A. SCHULTZ, and W.H. WENNER. 1969.
Sleep cycle characteristics in infants.
Pediatrics 43:65-70.

96. STUSSI, T., and M.L. HARMELIN. 1966.
Research on the ontogenesis of the circadian rhythm of the expenditure of energy in the honey bee.
Comp. Rend. Acad. Sci. (Paris) Ser. D. 262(19):2066-2069.

97. VAN RANDENBORGH, H. and J. PECHSTEIN. 1966.
Principles of estimating infant mortality.
In: Handbuch der Kinderheilkunde, B. III. Springer, Berlin.
P. 1126.

98. ZARROW, M.X., et al.
FSH-induced ovulation in the immature rat.
Endocrinology 79:445-7.

99. ZARROW, M.X., et al. 1969.
The onset of the diurnal rhythm in ovarian cholesterol level in the rat, in relation to the onset of puberty and ovarian and uterine weight changes.
Neuroendocrinology 4:270-277.